WORKING PAPER NO. 79-3

INTER-CITY COMPARISONS OF CANADIAN HOUSEHOLD ENERGY COSTS

DARCY-GAIL ACKERMAN

JUNE, 1979

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ERRATA

INTER-CITY COMPARISONS OF CANADIAN HOUSEHOLD ENERGY COSTS

WORKING PAPER 79-3

Please make the following corrections to your copy.

1. TABLES 3, 5, 6: (Pages 8, 13 and 14)

   Annual gallon and Mcf consumption figures for space and water heating were calculated incorrectly. Using the example in Table 3, the approximate annual gallon consumption for water heating was calculated in the following manner:

$$\frac{40{,}000{,}000 \times .8}{166{,}600} = 192 \text{ gal.}$$

   Where: - 40,000,000 is the annual BTU consumption for water heating purposes per household.

   - .8 is the conversion efficiency of oil water heaters from BTUs to gallons

   - 166,600 are the number of BTUs generated by one imperial gallon of fuel oil

   The calculation should read as follows:

$$\frac{40{,}000{,}000}{166{,}600 \times .8} = 300 \text{ gal.}$$

   This error affects any analysis in the working paper which relies on annual gallon or Mcf consumption figures for space and water heating (electricity is not affected as it has a conversion efficiency of 100%).

2. TABLES 11, 12: (Pages 42 and 46)

   Annual Canadian energy costs per household for 1977 were calculated using a combination of 1977 and 1978 rates.

3. TABLE 1 (page 6)

   Microwave ovens have a saturation percentage of approximately 2% and therefore should not be included under 'basic electric users'.

CONTENTS

FIGURES.....iii

TABLES.....iv

ACKNOWLEDGEMENTS.....vi

INTRODUCTION.....1

CHARACTERISTICS OF ENERGY USE IN A HYPOTHETICAL CANADIAN HOME.....3

HOUSEHOLD ENERGY CONSUMPTION.....5

HOUSEHOLD ENERGY COSTS.....15

RESULTS.....21
- Vancouver.....41
- Calgary and Edmonton.....41
- Regina and Saskatoon.....43
- Winnipeg.....43
- Toronto and Ottawa.....44
- Thunder Bay.....44
- Montreal and Quebec.....44
- Saint John, Halifax and St. John's.....45
- Whitehorse and Yellowknife.....45

SUMMARY AND CONCLUSIONS.....47

APPENDIX A SATURATION PERCENTAGES.....52

APPENDIX B ELECTRICITY CONSUMPTION IN THE HOME.....63

APPENDIX C CLIMATIC DATA.....67

APPENDIX D HEATING UNIT EFFICIENCY.....72

APPENDIX E RATES.....74

FIGURES

FIGURE 1-A Vancouver (1977).....22

FIGURE 1-B Calgary (1977).....23

FIGURE 1-C Edmonton (1977).....24

FIGURE 1-D Regina (1977).....25

FIGURE 1-E Saskatoon (1977).....26

FIGURE 1-F Winnipeg (1977).....27

FIGURE 1-G Toronto (1977).....28

FIGURE 1-H Ottawa (1977).....29

FIGURE 1-I Thunder Bay (1977).....30

FIGURE 1-J Montreal (1977).....31

FIGURE 1-K Quebec (1977).....32

FIGURE 1-L Saint John (1977).....33

FIGURE 1-M Halifax (1977).....34

FIGURE 1-N St. John's (1977).....35

FIGURE 1-O Whitehorse (1977).....36

FIGURE 1-P Yellowknife (1977).....37

FIGURE 2-A Clothes Dryers (1977).....38

FIGURE 2-B Ranges (1977).....38

FIGURE 2-C Space Heating (1977).....39

FIGURE 2-D Water Heating (1977).....40

TABLES

TABLE 1 Single Family Residential Electricity Consumption (kilowatt-hours).....6

TABLE 2 Single Family Residential Gas Consumption (thousands of cubic feet).....7

TABLE 3 Single Family Residential Oil Consumption (gallons).....8

TABLE 4 Annual Electricity Consumption of Space Heaters....10

TABLE 5 Annual Gas Consumption of Space Heaters.....13

TABLE 6 Annual Oil Consumption of Space Heaters.....14

TABLE 7 Basic Residential Electric Usage for All Customers (1977).....17

TABLE 8 Total Residential Electricity Annual Cost (1977)...18

TABLE 9 Total Residential Gas Annual Cost (1978).....19

TABLE 10 Total Residential Oil Annual Cost (1977).....20

TABLE 11 Annual Canadian Energy Costs per Household (1977)..42

TABLE 12 Annual Canadian Energy Costs per Household (1977)..46

TABLE A-1 Hypothetical Canadian Home Description, Saturation Percentages, 1977.....55

TABLE A-2 General Appliances, Saturation Percentages, 1977...56

TABLE A-3 Clothes Dryers, Saturation Percentages, 1977.....57

TABLE A-4 Fuel for Cooking Equipment, Saturation Percentages, 1977.....58

TABLE A-5 Principal Heating Fuel For Single Dwellings Only, Saturation Percentages, 1977.....59

TABLE A-6 Fuels For Piped Hot Water Supply For Single Dwellings Only, Saturation Percentages, 1977.....60

TABLE A-7 Principal Heating Equipment For Single Dwellings Only, Saturation Percentages, 1977.....61

TABLE A-8 Principal Heating Equipment for Single Dwellings Only by Fuel, Canada, Saturation Percentages, 1977.....62

TABLE B-1 Determination of Home Lighting Electricity Consumption (kilowatt-hours).....65

TABLE B-2 Miscellaneous Electricity Consumption.....66

TABLE C-1 Degree-Days Below 18°C, 1977 (Normalized).....68

TABLE C-2 Conversion of Degree-Days from Celsius to Fahrenheit, 1977 Normalized Data.....69

TABLE C-3 Minimum Monthly Average Temperatures, Celsius.....70

TABLE C-4 Conversion of Lowest Minimum Monthly Average Temperatures from Celsius to Fahrenheit.....71

TABLE E-1 Residential Electricity Rates (1977).....75

TABLE E-2 Residential Gas Rates (1977).....76

TABLE E-3 Residential Oil Rates (1977).....77

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INTRODUCTION

About 32 percent of Canada's total use of energy is accounted for in the home.[1] Consumers across the country encounter a considerable range in the price of energy. The purpose of this paper is to compare residential energy costs and various cost components in different parts of Canada. Three major fuel types — electricity, gas, and oil — have been selected as the basis for comparison.

Certain assumptions were made regarding the characteristics of the home to be studied. Information regarding type of dwelling, number of bedrooms, appliances, insulation standards, and square footage was collected to support the assumptions.

Fuel consumption was approached in three steps: a) basic electricity usage, b) clothes dryer and range usage and fuel options, and c) space and water heater usage and fuel options.

Basic electricity consumption is the total amount of kilowatt-hour usage, expressed as a constant or fixed quantity in each home. This value represents the electricity consumption for which there are no substitutes.

Clothes dryers and ranges are considered separately because two fuel options, electricity and gas, are available to the consumer.[2] Consumption of each fuel is assumed to be constant.

Space and water heaters represent the largest energy users in the home. Three fuel options — electricity, gas, and oil — are available to the consumer.[3] Consumption of each fuel varies, depending on factors such as heat loss, degree days, and temperature.

Along with the assembly of data on energy use, utility rates for the different fuel types were collected. Household energy costs were taken as a function of the quantity used and the rates. The results pertaining to Canadian residential energy costs in 1977 indicate that energy costs for a family living in a well-insulated, three bedroom home, and making use of the cheapest alternatives, could range from about $500 to nearly $900 per year in the major cities across the country, and to considerably higher amounts in the Yukon and the Northwest Territories.

CHARACTERISTICS OF ENERGY USE IN A HYPOTHETICAL CANADIAN HOME

The hypothetical Canadian home used in this study is single detached, has three bedrooms, and measures 1,270 square feet.[4] Insulation standards proposed by Energy, Mines and Resources Canada serve as further qualifications for this home.[5] Details concerning the methodology in selection of the characteristics of the hypothetical Canadian home are found in Appendix A.

The remainder of this section is devoted to building a set of estimates of the various components of energy use in the three bedroom home, depending on where it is located in Canada and what its energy sources would be. The majority of the energy consumed is accounted for by space heating. Approximations of the variation in this component are developed using procedures for estimating that have been developed by the heating industry. The remaining uses of energy are taken as fixed although the sources of energy used for clothes dryers, ranges, and water heaters are allowed to vary. Account will be taken of the price variations between cities, and estimates of the costs of meeting these energy requirements will be developed, given the various energy sources that are available.

The following items represent the various energy users characterizing the hypothetical Canadian home:[6]

a) Basic electricity usage

Home Lighting
Refrigerator
Micro-wave Oven
Freezer
Vacuum Cleaner
Automatic Washer
Record-playing Equipment
Color Television
Miscellaneous[7]

b) Clothes Dryer and Range usage of electricity or gas.

c) Space and Water Heater usage of electricity, gas, or oil.

HOUSEHOLD ENERGY CONSUMPTION

Tables 1, 2 and 3 illustrate the approximate annual rates of consumption assumed for electricity, gas, and oil for the various energy uses, other than space heating. These consumption levels will be assumed to be constant across the country. The exception is space heaters, whose consumption is sensitive not only to type of fuel used, but also to geographic location.

Annual fuel consumption of space heaters, whether fuelled by electricity, gas, or oil, varies due to certain factors specific to each fuel type.

Annual electric space heater consumption can be expressed as follows:[8]

$$\text{Annual Consumption (kW.h/yr.)} = \frac{\text{Heat Load} \times \text{Degree Days} \times \text{Constant}}{\text{Design Temperature Difference}}$$

Heat load is equal to heat loss. The value of heat load is 100,000 Btus.[9] Heat loss is the "amount of heat a home loses to the outdoors through walls, ceilings, windows, etc., when the outdoor temperature is lower than the indoor temperature. This represents the amount of heat that must be added to a home by its heating system."[10]

TABLE 1

SINGLE FAMILY RESIDENTIAL ELECTRICITY CONSUMPTION
(kilowatt-hours)

Consumption by	Approximate Annual kW.h Consumption[a]
A. Basic electricity users	
Home lighting	576
Refrigerator	1,800
Micro-wave oven	264
Freezer	1,080
Vacuum cleaner	48
Automatic washer	96
Record-playing equipment	72
Color television	480
Miscellaneous[b]	1,260
Total	5,676
B. Clothes dryer	960
Range	1,200
Total	2,160
C. Space heater	*
Water heater (Cascade)	6,000

SOURCES: "How You Use the Electricity You Use," Ontario Hydro. 984-0343:1 A Conserve Energy Publication; and "Your Meter is Running. A Guide to Managing Your Kilowatts," Calgary Power.
For more information, see Appendix B.

NOTES: [a]Calculated from monthly data.

[b]Approximately 10 percent of total single family residential electricity consumption, excluding space heating.

* Varies.

TABLE 2

SINGLE FAMILY RESIDENTIAL GAS CONSUMPTION
(thousands of cubic feet)

Consumption by	Approximate Annual mcf Consumption[a]
A. Clothes dryer	8
Range	4
Total	12
B. Space heater	*
Water heater	40

SOURCE: Conversation with Canadian Western Natural Gas Co. Ltd., Calgary, July 18, 1978.

NOTES: [a]Annual consumption figures given for a family of four.

*Varies.

TABLE 3

SINGLE FAMILY RESIDENTIAL OIL CONSUMPTION
(gallons)

Consumption by	Approximate Annual Gallon Consumption
Space heater	*
Water heater	196[a]

NOTES: [a]Annual consumption of hot water for heating purposes is about 40 million Btus per household. (Conversation with Shell Oil, Toronto, July 18, 1978.) This is equivalent to 196 gallons per year at 80 percent efficiency. (Conversion efficiency of oil water heaters from Btus to gallons is about 80 percent. See Appendix D.)

*Varies.

The number of degree days varies both seasonally and geographically. "The difference between 65°F and the mean temperature for the day is the number of degree days for that day."[11] For more details, refer to Appendix C.

The constant used in the formula represents the experience factor of the electric utility. The experience factor ranges between 14 and 18 depending on a) the number of people living in the house, b) the ages of the people living in the house, c) the geographic location of the house (latitude and longitude), and d) the degree of exposure of the house to the elements.[12] For simplicity reasons, I am assuming the Canadian average experience factor to be 15.

Design temperature difference "is the difference in degrees Fahrenheit between the outdoor design temperature and indoor design temperature."[13] Indoor and outdoor design temperatures refer to the indoor and outdoor air temperatures for which the heating system is designed.[14] The value of the temperature difference for purposes of this study has been arbitrarily chosen to be 100°F. This represents the difference between an indoor design temperature of 70°F and an outdoor design temperature of -30°F.[15] This value will be held constant across the country for ease of calculation.

The annual consumption of electricity for space heating that would be required for a three bedroom home in the various Canadian cities, computed as outlined above, would vary as indicated in Table 4.

TABLE 4

ANNUAL ELECTRICITY CONSUMPTION OF SPACE HEATERS

Cities	Total Degree-Days Fahrenheit (1977)	Approximate Annual Consumption (kW.h/yr.)[a]
Vancouver	5,431	23,625
Calgary	9,639	41,930
Edmonton	10,078	43,839
Regina	10,674	46,432
Saskatoon	10,957	47,663
Winnipeg	10,618	46,188
Toronto	7,366	32,042
Ottawa	8,429	36,666
Thunder Bay	10,361	45,070
Montreal	7,886	34,304
Quebec	9,162	39,855
Saint John	8,606	37,436
Halifax	7,439	32,360
St. John's	8,665	37,693
Whitehorse	12,400	53,940
Yellowknife	15,485	67,360

NOTES: [a]Btus are converted to kW.h for use in the formula. Conversion efficiency of electric space heaters from Btus to kW.h is 100 percent. For more details, see Appendix D.

Annual gas space heater consumption can be expressed as follows:[16]

$$H = \frac{kD\ h}{1000}$$

OR Heat to be Supplied (Btus/Normal Heating Season) =

$$\text{Constant} \times \text{Degree Days} \times \frac{\text{Heat Loss}}{1000}$$

The value of heat loss in the formula is 100,000 Btus.[17] Heat loss is expressed in thousands of Btus per hour at design conditions.[18]

The constant, k, varies between cities. It represents the heat to be supplied, expressed in Btus per degree-day per 1000 Btus per hour of heat loss at design conditions for the particular city.[19]

$$k = \frac{24\ (5d + D)\ 1000}{(70 - to)\ D}$$

OR Constant =

$$\frac{24(5 \times \text{No. of Days in Heating Season} + \text{Degree Days})\ 1000}{(70 - \text{Outside Design Temperature})\ \text{Degree Days}}$$

The heating season for a particular year begins on the date when the normal daily mean temperature drops below 65°F, and ends where it rises above 65°F. The value of the number of days in the heating season is calculated for each city as the number of days between these two crossings.[20]

The outside design temperature, represented by to, is expressed in degrees Fahrenheit.[21] The value of to varies regionally and seasonally. Estimates have been calculated repre-

senting the minimum monthly temperature to which the heating system must be designed in order that adequate heating comfort is provided on even the coldest days of the year.

The annual consumption of gas for space heating that would be required for a three bedroom home in the various Canadian cities, computed as outlined above, would vary as indicated in Table 5.

Since no formulas for calculating annual oil space heater consumption could be found, an estimation method was used. Toronto was arbitrarily chosen as the base city from which all other comparisons would be made. The main objective was to establish an order of magnitude for oil consumption between the various cities.

The resultant estimates of annual consumption of oil for space heating that would be required for a three bedroom home in the various Canadian cities are provided in Table 6.

TABLE 5

ANNUAL GAS CONSUMPTION OF SPACE HEATERS

Cities	Number of Days in Heating Season[a]	Total Degree-Days Fahrenheit (1977)	Minimum Outside Design Temperature[b] (^{o}F)	Constant	Annual Consumption (Without Efficiency Considerations) (millions)	Approximate Annual Consumption[c] (mcf/yr.)
Vancouver	288	5,431	0	434	236	189
Calgary	266	9,639	-35	260	251	201
Edmonton	291	10,078	-40	250	252	202
Regina	271	10,674	-40	246	263	210
Saskatoon	270	10,957	-40	245	268	214
Winnipeg	246	10,618	-40	243	258	206
Toronto	243	7,366	-20	311	229	183
Ottawa	252	8,429	-25	290	244	195
Thunder Bay	270	10,361	-40	247	256	205
Montreal	245	7,886	-20	308	243	194
Quebec[d]						
Saint John						
Halifax						
St. John's						
Whitehorse						
Yellowknife						

NOTES: [a]Calculated from "Monthly Record of Meteorological Observations in Canada," Fisheries and Environment Canada. Atmospheric Environment. 1972-1976.

[b]Estimates based on "Canadian Weather Review," Fisheries and Environment Canada. Atmospheric Environment. Jan., Feb., Nov. data - Vols. 11-15, Nos. 1,2,11; Dec. data - Vols. 10,11,12,13,15, No. 12.

[c]Btus are converted to mcf for use in the formula. Conversion efficiency of gas space heaters from Btus to mcf is about 80 percent. For more details, see Appendix D.

[d]Gas is not available to consumers east of Montreal because, at the present time, TransCanada PipeLines' transmission line terminates just beyond Montreal, and no distribution lines run to eastern Quebec and the Atlantic provinces.

TABLE 6

ANNUAL OIL CONSUMPTION IN SPACE HEATERS

Cities	Approximate Annual Electricity Consumption (kW.h/hr.)		Approximate Annual Oil Consumption (gals./yr.)
Vancouver	23,625		557
Calgary[a]	-		-
Edmonton	-		-
Regina	46,432		1,096
Saskatoon	47,663		1,125
Winnipeg	46,188		1,090
Toronto	32,042	=	756[b]
Ottawa	36,666		865
Thunder Bay	45,070		1,063
Montreal	34,304		809
Quebec	39,855		940
Saint John	37,436		883
Halifax	32,360		764
St. John's	37,693		889
Whitehorse	53,940		1,273
Yellowknife	67,360		1,589

NOTES: [a]Fuel oil is not priced in Alberta. (From Statistics Canada and Shell Marketing.)

[b]Consumption of oil space heating for Canada is about 155 million Btus per household. (Conversation with Shell Oil, Toronto, July 18, 1978.) The Toronto figure of 756 gallons per year was chosen on the basis of the following calculation:

5.8275 MMBtus = 1 barrel (Statistics Canada)
Therefore, 155 MMBtus = 27 barrels
1 barrel = 35 Canadian gallons (Statistics Canada)
Therefore, 27 barrels = 945 Canadian gallons
945 gallons x 80% efficiency (see Appendix D)
= 756 gallons per year

HOUSEHOLD ENERGY COSTS

A rate is a price charged for a particular service. Rate schedules include "the rate plus the several provisions necessary for billing for various load conditions of the customers."[22] Costs of service may be broken down into several parts. For purposes of this paper, three cost elements – energy charge, service charge, and minimum charge – will be discussed.

Energy charge is a function of the quantity of energy supplied to customers.[23] The service charge varies with the "number of customers served and includes investment charges and expenses relative to a portion of the general distribution system, service drop or other local connection facilities, metering equipment, meter reading, billing, and accounting."[24] The minimum charge covers "some of the costs of serving a customer whether the customer uses energy or not. In rates for smaller loads, the minimum charge may be looked upon as partially including such customer cost items as service drop, meter, meter reading, and billing ... Managerial judgment and the size of the utility strongly influence the character of minimum charges."[25]

Table 7 represents basic electricity usage, expressed in dollars, for all residential customers. The total annual cost includes service charges where applicable. The costs incurred

through the operation of a space heater, water heater, clothes dryer, or a range are not included. The electricity rates vary across the country, but consumption is assumed to be constant.

Table 8 represents electricity costs for the operation of a space heater, water heater, clothes dryer, and a range. Each column represents the incremental cost of electricity in the block after basic consumption. No service charges are included.

Table 9 represents gas costs for the operation of a space heater, water heater, clothes dryer, and a range. Service charges frequently are applicable with gas rates (see Appendix E), but are not included in this table for ease of comparison.

Table 10 represents oil costs for the operation of a space and water heater. No service charges are included in the price of oil.

TABLE 7

BASIC RESIDENTIAL ELECTRIC USAGE FOR ALL CUSTOMERS
(1977)

Cities	Total Annual Cost ($)
Vancouver	217.32
Calgary	153.24
Edmonton	149.40
Regina	172.44
Saskatoon	185.76
Winnipeg	161.88
Toronto	181.44
Ottawa	146.64
Thunder Bay	190.32
Montreal	130.56
Quebec	130.56
Saint John	256.80
Halifax	267.72
St. John's	221.40
Whitehorse	268.92
Yellowknife	298.32

NOTES: Cost of operation = kilowatt hours used x cost per kilowatt hour*
Formula from "A Guide to Operating Costs of Electric Appliances," Calgary Power.
*See Appendix E.

Total annual cost determined from average monthly cost. Monthly kW.h consumption = 473
Annual kW.h consumption = 5,676

TABLE 8

TOTAL RESIDENTIAL ELECTRICITY ANNUAL COST
(1977)

Cities	Space Heater ($)	Water Heater ($)	Clothes Dryer ($)	Range ($)
Vancouver	472.50	120.00	19.20	24.00
Calgary	893.11	127.80	20.45	25.56
Edmonton	898.70	123.00	19.68	24.60
Regina	1,021.50	132.00	21.12	26.40
Saskatoon	1,191.58	150.00	24.00	30.00
Winnipeg	877.57	114.00	18.24	22.80
Toronto	769.01	144.00	23.04	28.80
Ottawa	824.99	135.00	21.60	27.00
Thunder Bay	991.54	132.00	21.12	26.40
Montreal	531.71	93.00	14.88	18.60
Quebec	617.75	93.00	14.88	18.60
Saint John	1,985.33	202.56	37.34	46.68
Halifax	1,823.45	201.84	33.60	42.00
St. John's	810.40	129.00	20.64	25.80
Whitehorse	1,790.81	199.20	31.92	39.84
Yellowknife	3,260.22	290.40	46.46	58.08

NOTES: Cost of operation = kilowatt hours used x cost per kilowatt hour*
Formula from "A Guide to Operating Costs of Electric Appliances," Calgary Power.
*See Appendix E.

Average monthly cost figures calculated from annual data.

TABLE 9

TOTAL RESIDENTIAL GAS ANNUAL COST[a]
(1978)

Cities	Space Heater ($)	Water Heater ($)	Clothes Dryer ($)	Range ($)
Vancouver	378.00	79.92	16.08	7.92
Calgary	269.52	46.80	12.00	7.68
Edmonton	373.68	68.52	18.24	11.88
Regina	295.32	37.92	30.72	30.72
Saskatoon	301.08	37.92	30.72	30.72
Winnipeg	486.00	108.72	30.84	19.32
Toronto	553.92	135.60	41.64	30.60
Ottawa	588.48	135.60	41.64	30.60
Thunder Bay	389.40	115.08	54.00	54.00
Montreal	514.80	152.40	47.88	33.96
Quebec	-	-	-	-
Saint John	-	-	-	-
Halifax	-	-	-	-
St. John's	-	-	-	-
Whitehorse	-	-	-	-
Yellowknife	-	-	-	-

NOTES: [a]Service charges are not included, but must be applied.

Cost of operation = mcf used x cost per mcf. (See Appendix E.)

Dashes indicate insufficient data.

TABLE 10

TOTAL RESIDENTIAL OIL ANNUAL COST
(1977)

Cities	Space Heater ($)	Water Heater ($)
Vancouver	280.68	98.76
Calgary*	-	-
Edmonton*	-	-
Regina	532.68	95.28
Saskatoon	542.28	94.44
Winnipeg	522.12	93.84
Toronto	378.72	98.16
Ottawa	448.08	101.52
Thunder Bay	545.28	100.56
Montreal	408.60	99.00
Quebec	483.12	100.80
Saint John	448.56	99.60
Halifax	380.52	97.56
St. John's	484.56	106.80
Whitehorse	860.52	132.48
Yellowknife	1,112.28	137.16

NOTES: Cost of operations = gallons of oil used x cost per gallon. (See Appendix E).

*There are no Alberta prices for furnace oil because oil is not marketed as the product "furnace oil," but instead as "stove oil." (From Shell Marketing.)

Total annual cost determined from average monthly cost.

RESULTS

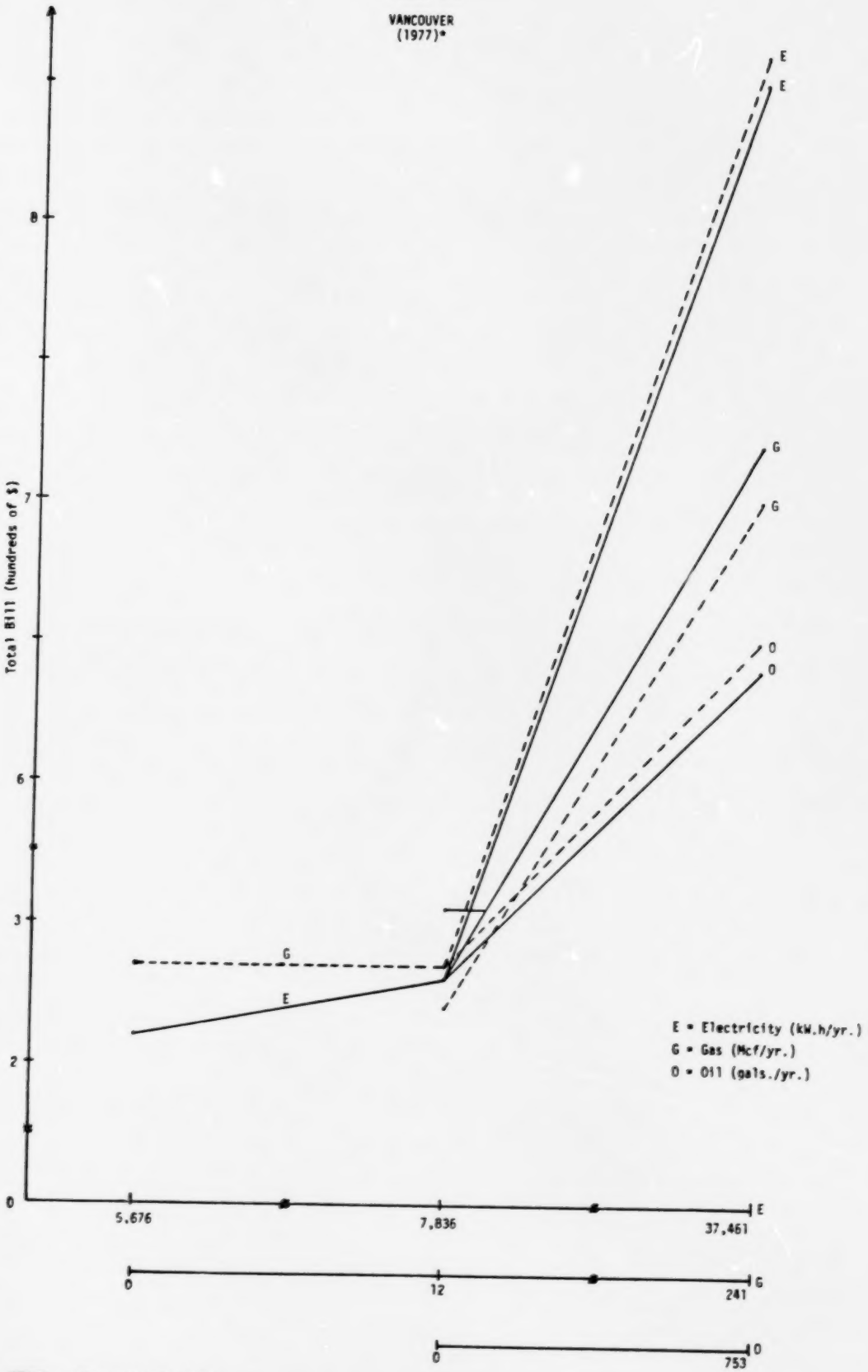
Figures 1-A to 1-P graphically represent total residential customer bills for varying levels of home energy consumption in each city. The graphs illustrate the results of this study.[26]

In the graphs, basic electricity consumption estimated at 5,676 kilowatt-hours in Table 1, is assumed to be used in each city. Clothes dryer and range consumption are considered next, using 2,160 kilowatt-hours of electricity (Table 1), or 12 thousand cubic feet of gas[27] (Table 2). Various fuel alternatives for space and water heating are illustrated in the third part of the graphs.[28] Water heating, at 6,000 kilowatt-hours of electricity, 40 thousand cubic feet of gas, or 196 gallons of oil, is coupled with varying quantities of electricity, gas, or oil for space heating (as shown in Tables 4, 5, and 6). Using Toronto as an example, when consumption levels are combined with the rate schedules, the lowest cost option is electricity for basic uses and for a clothes dryer and range, and oil for space and water heating.[29]

Figures 2-A, B, C, and D, graphically represent residential customer saturation percentages for clothes dryers, ranges, and heaters in each city[30] (except Whitehorse and Yellowknife).[31] The graphs illustrate which fuels households are actually using. The

FIGURE 1-A

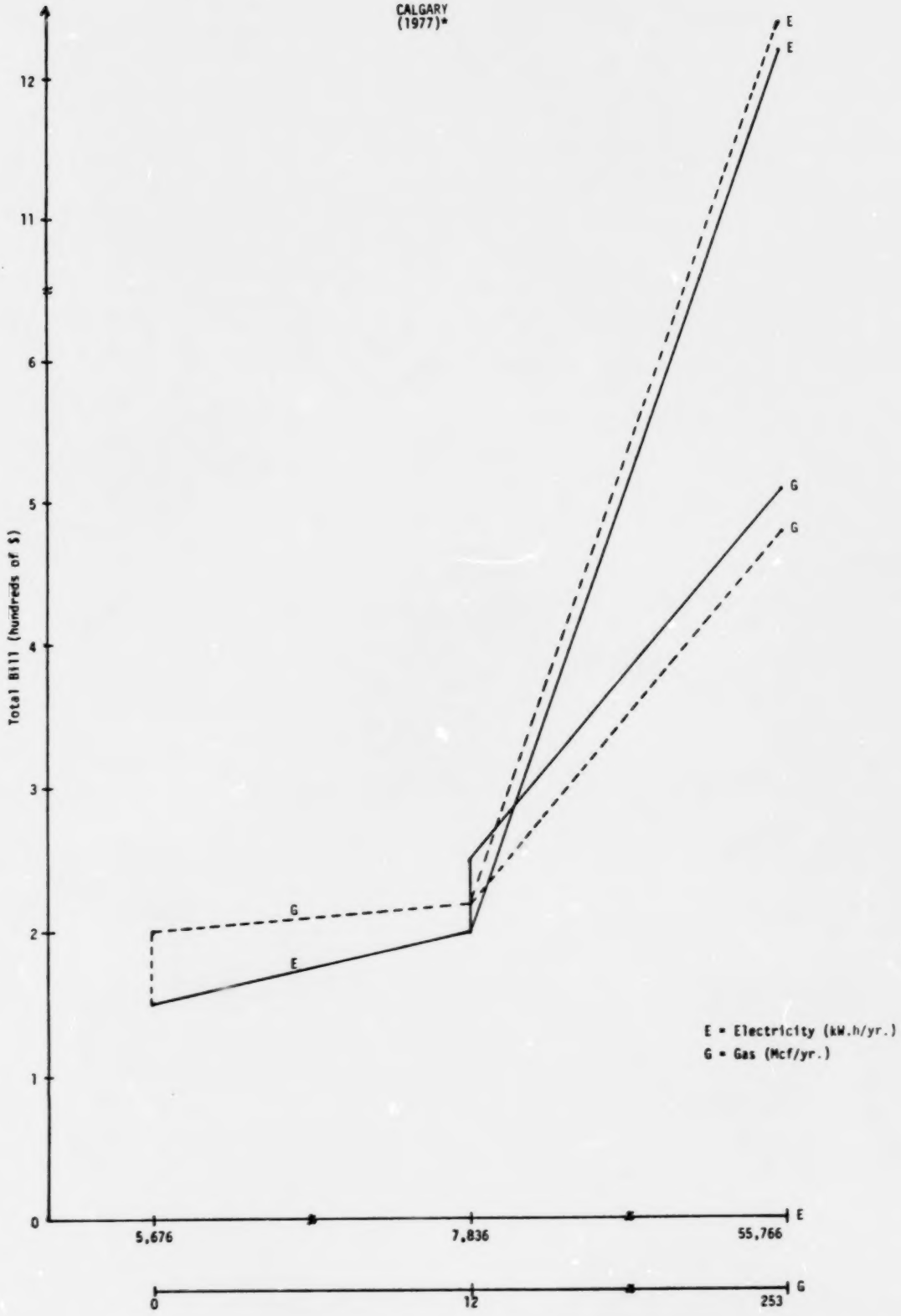
VANCOUVER
(1977)*



NOTES: *Gas cost data 1978.
Service charges included in base electricity usage.
Annual sum of minimum monthly bills included where applicable in gas rates.

FIGURE 1-B

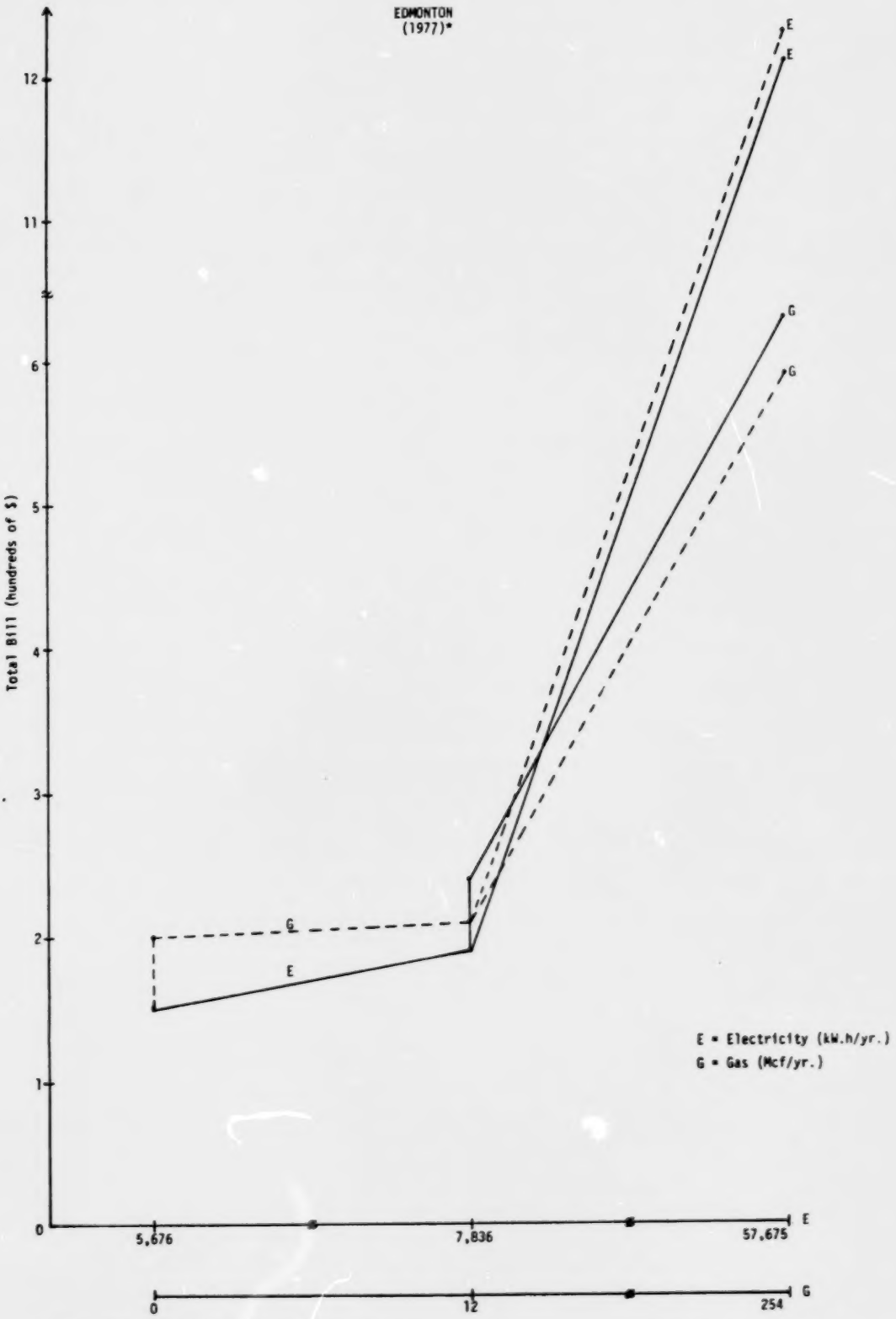
CALGARY
(1977)*



NOTES: *Gas cost data 1978.
Service charges included in base electricity usage. They are graphically illustrated as a ratchet effect for gas.

FIGURE 1-C

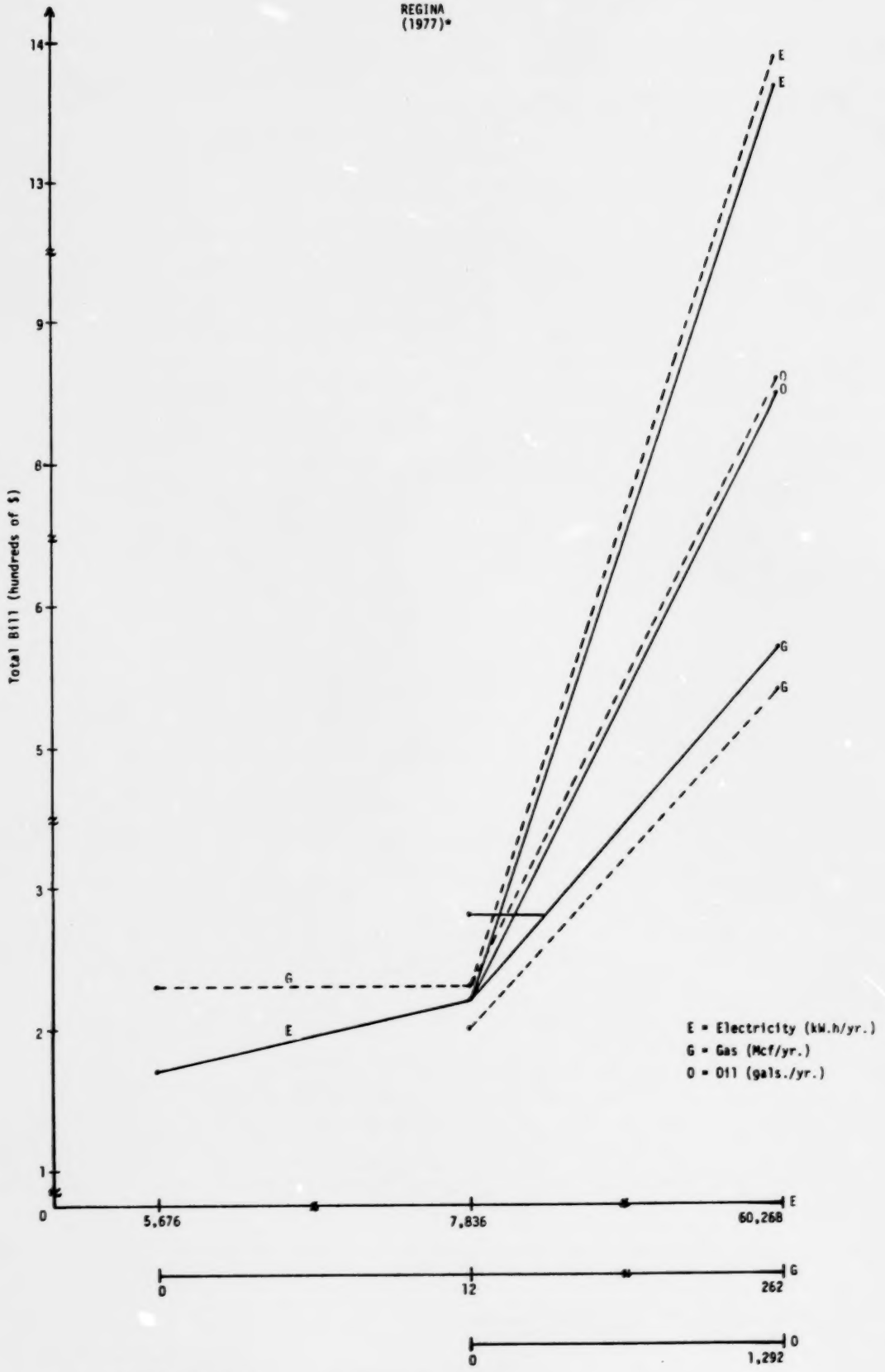
EDMONTON
(1977)*



NOTES: *Gas cost data 1978.
Service charges included in base electricity usage.
They are graphically illustrated as a ratchet effect for gas.

FIGURE 1-D

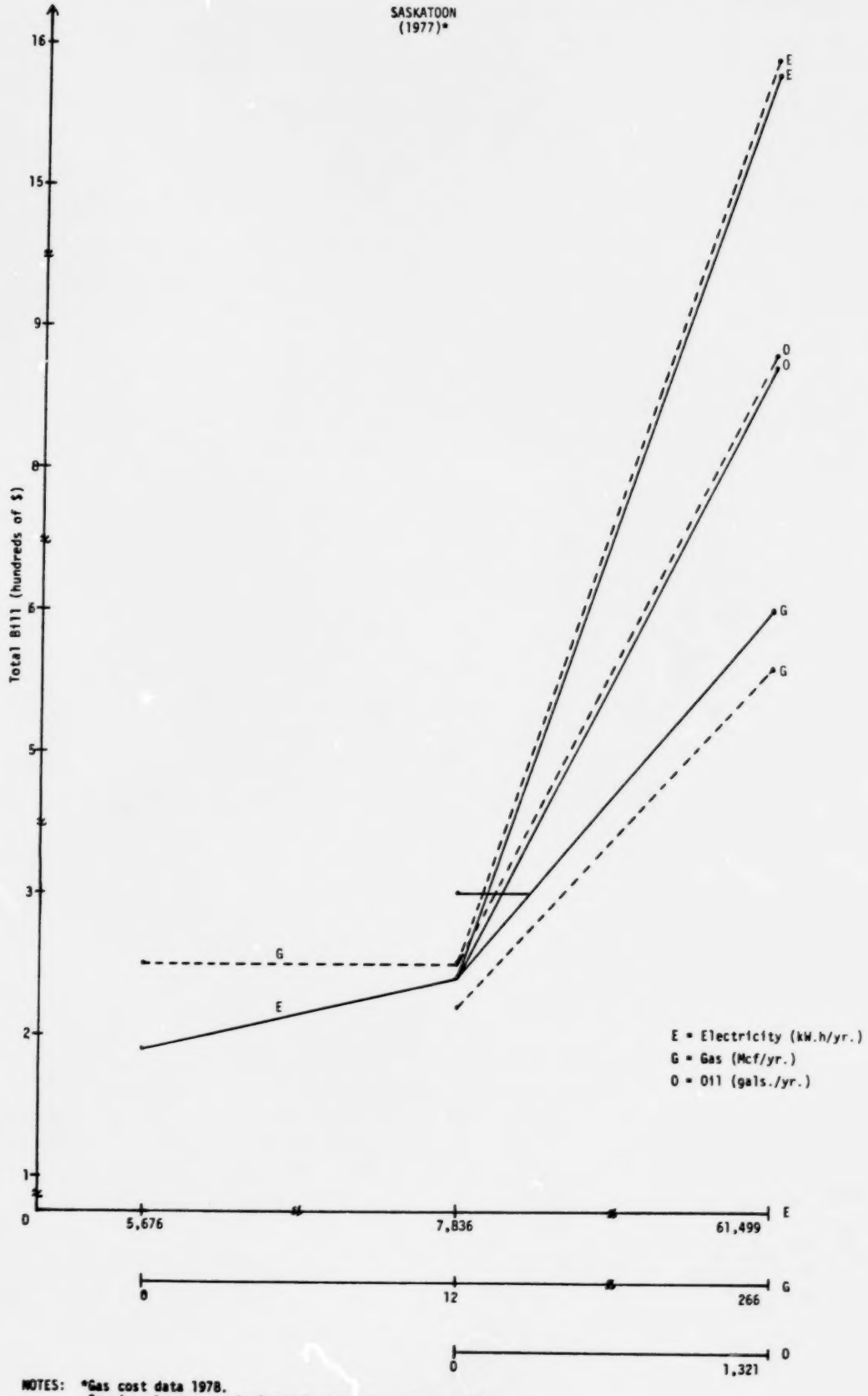
REGINA
(1977)*



NOTES: *Gas cost data 1978
Service charges included in base electricity usage.
Annual sum of minimum monthly bills included in gas usage where applicable.

FIGURE 1-E

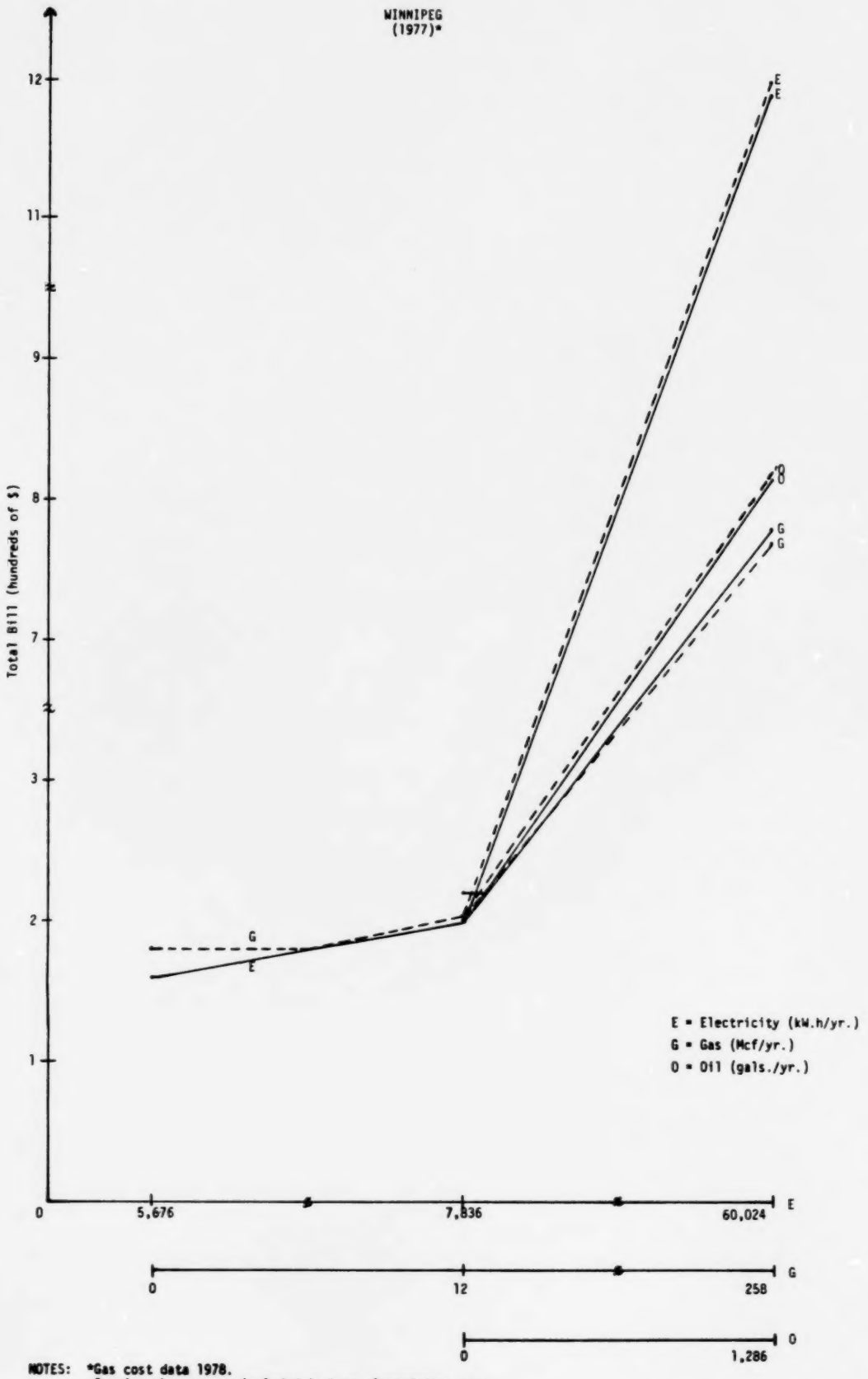
SASKATOON
(1977)*



NOTES: *Gas cost data 1978.
Service charges are included in base electricity usage.
Annual sum of minimum monthly bills included in gas usage where applicable.

FIGURE 1-F

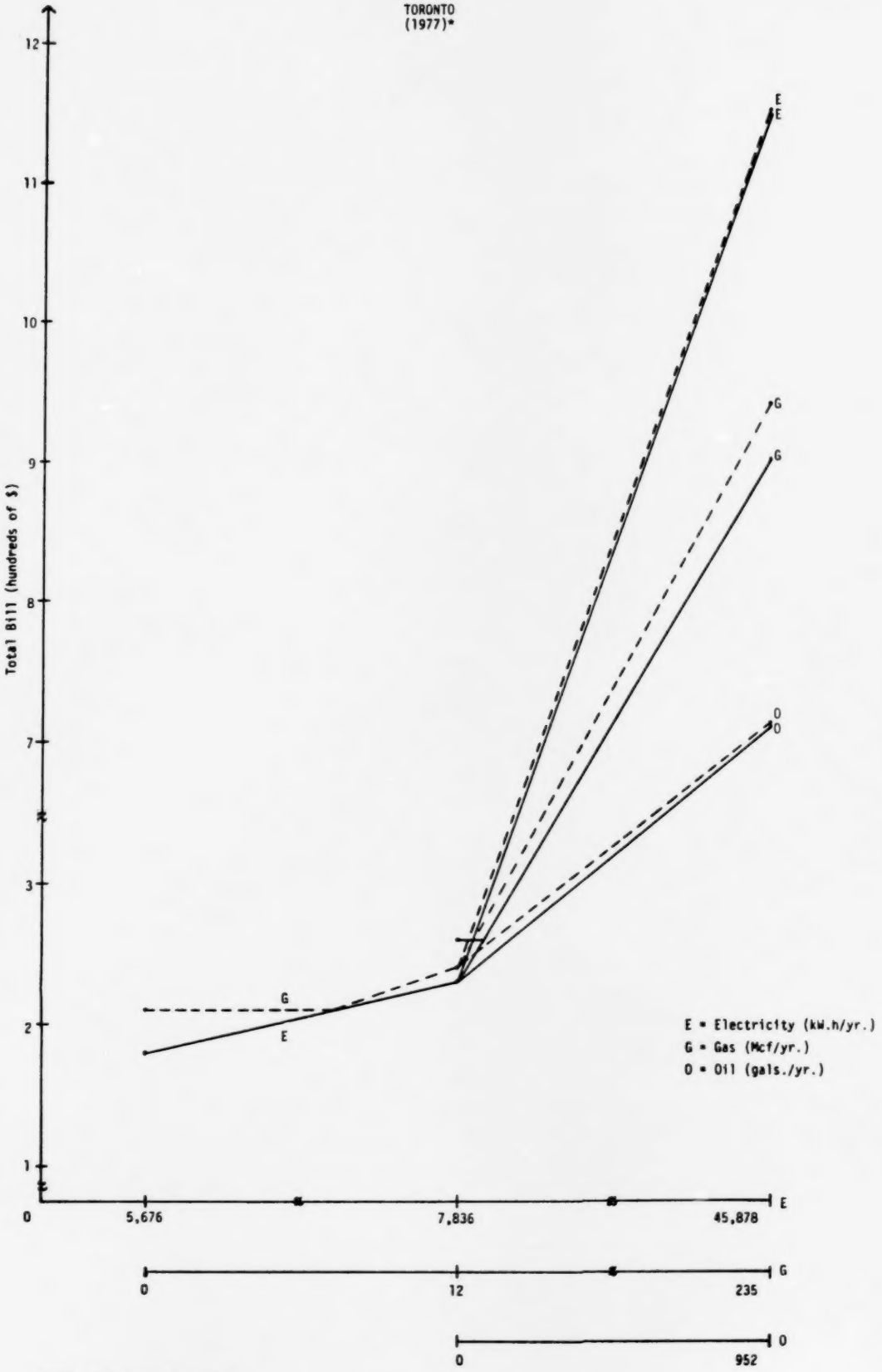
WINNIPEG
(1977)*



NOTES: *Gas cost data 1978.
Service charges are included in base electricity usage.

FIGURE 1-G

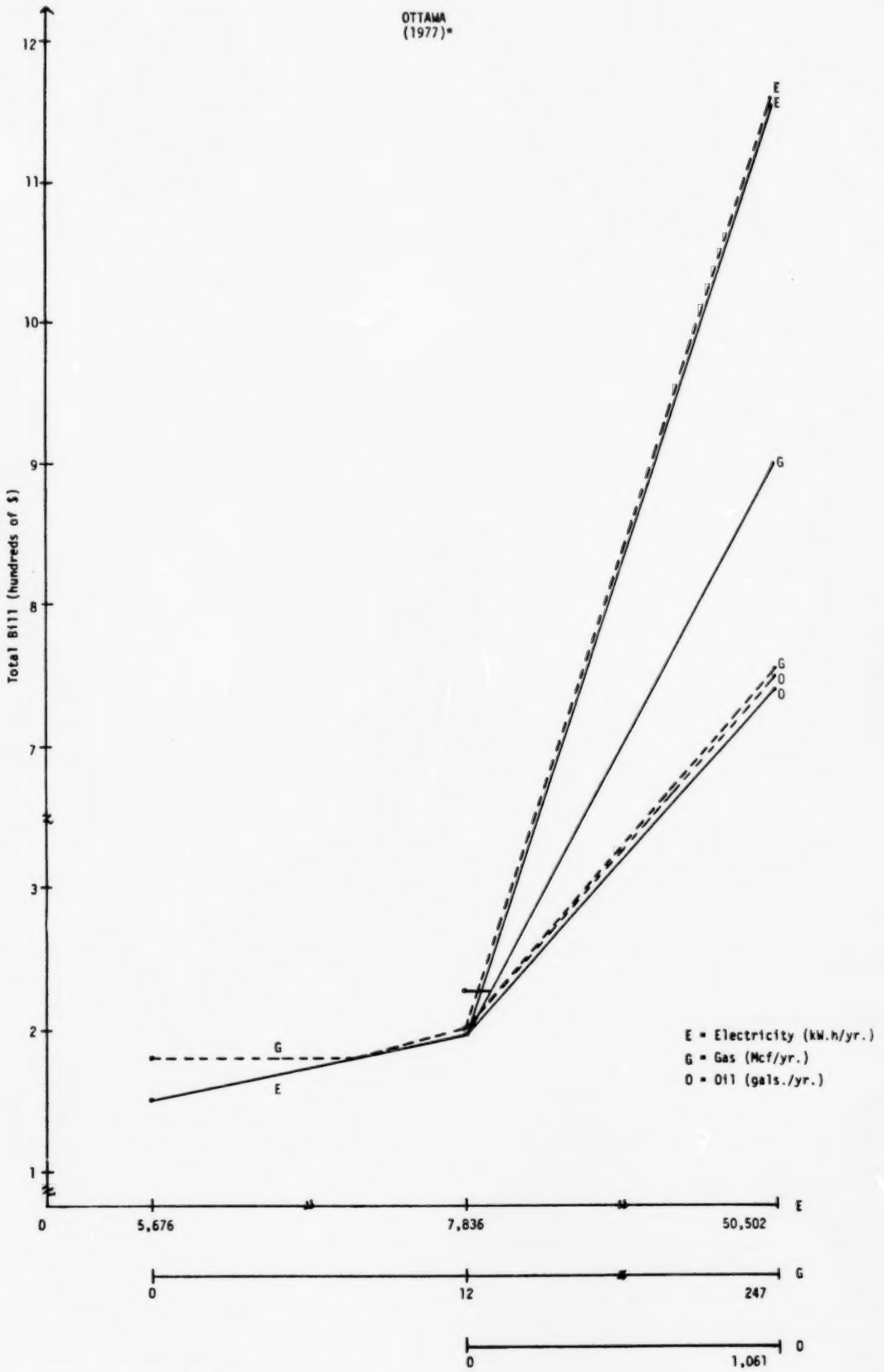
TORONTO
(1977)*



NOTES: *Gas cost data 1978.
. Service charges are included in base electricity usage.

FIGURE 1-H

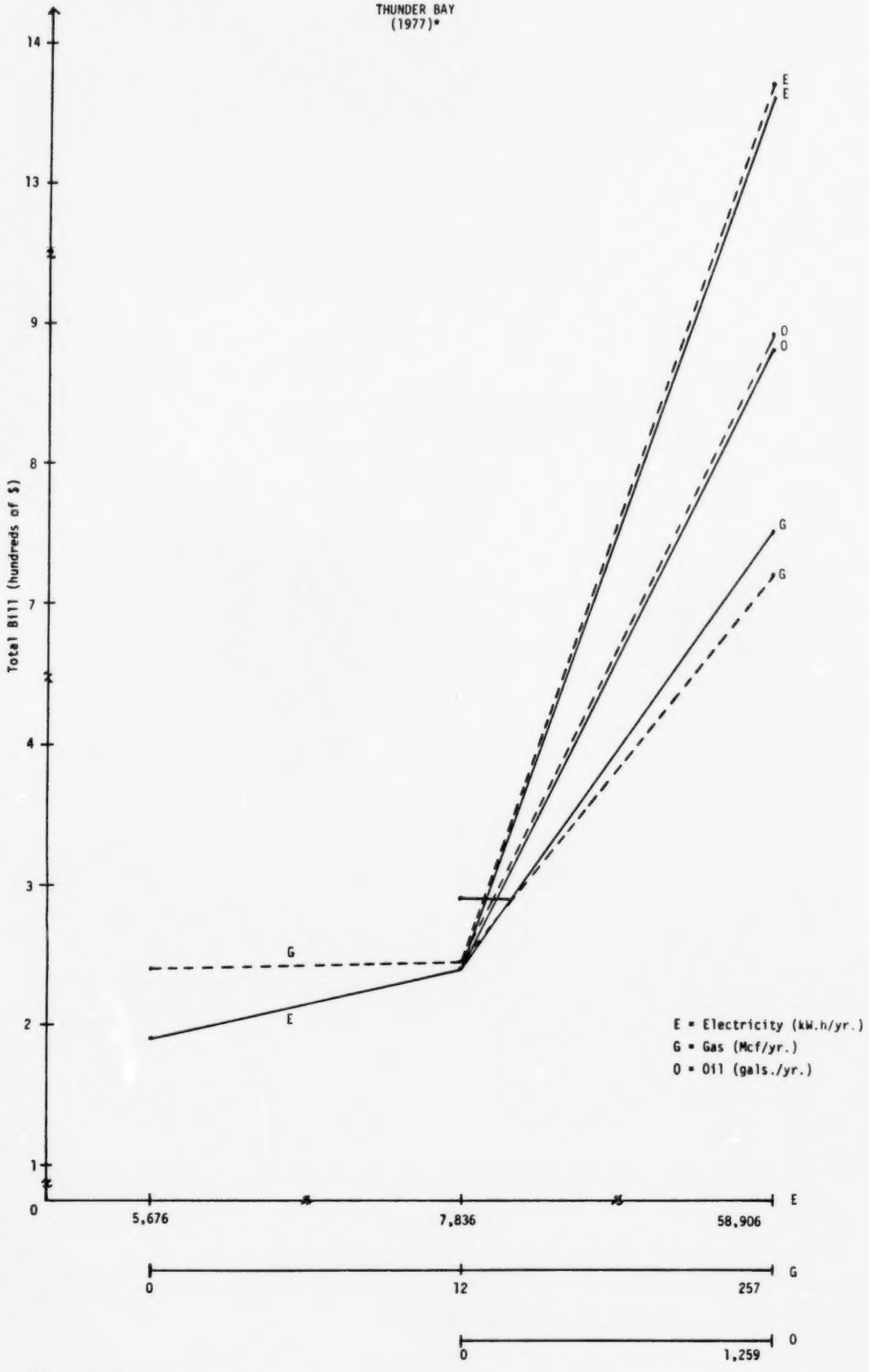
OTTAWA
(1977)*



NOTES: *Gas cost data 1978.
Service charges are included in base electricity usage.

FIGURE 1-I

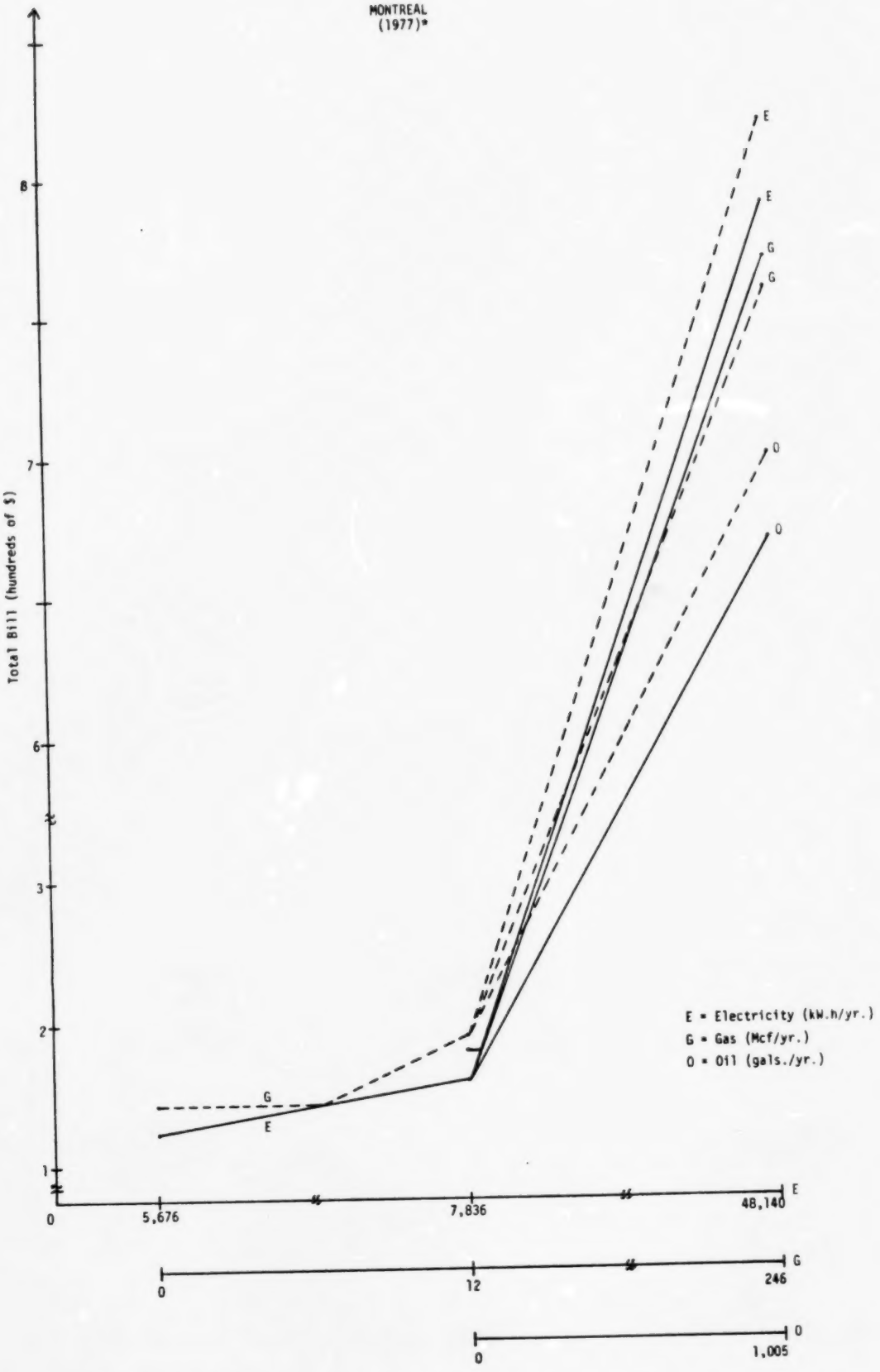
THUNDER BAY
(1977)*



NOTES: *Gas cost data 1978.
Service charges are included in base electricity usage.

FIGURE 1-J

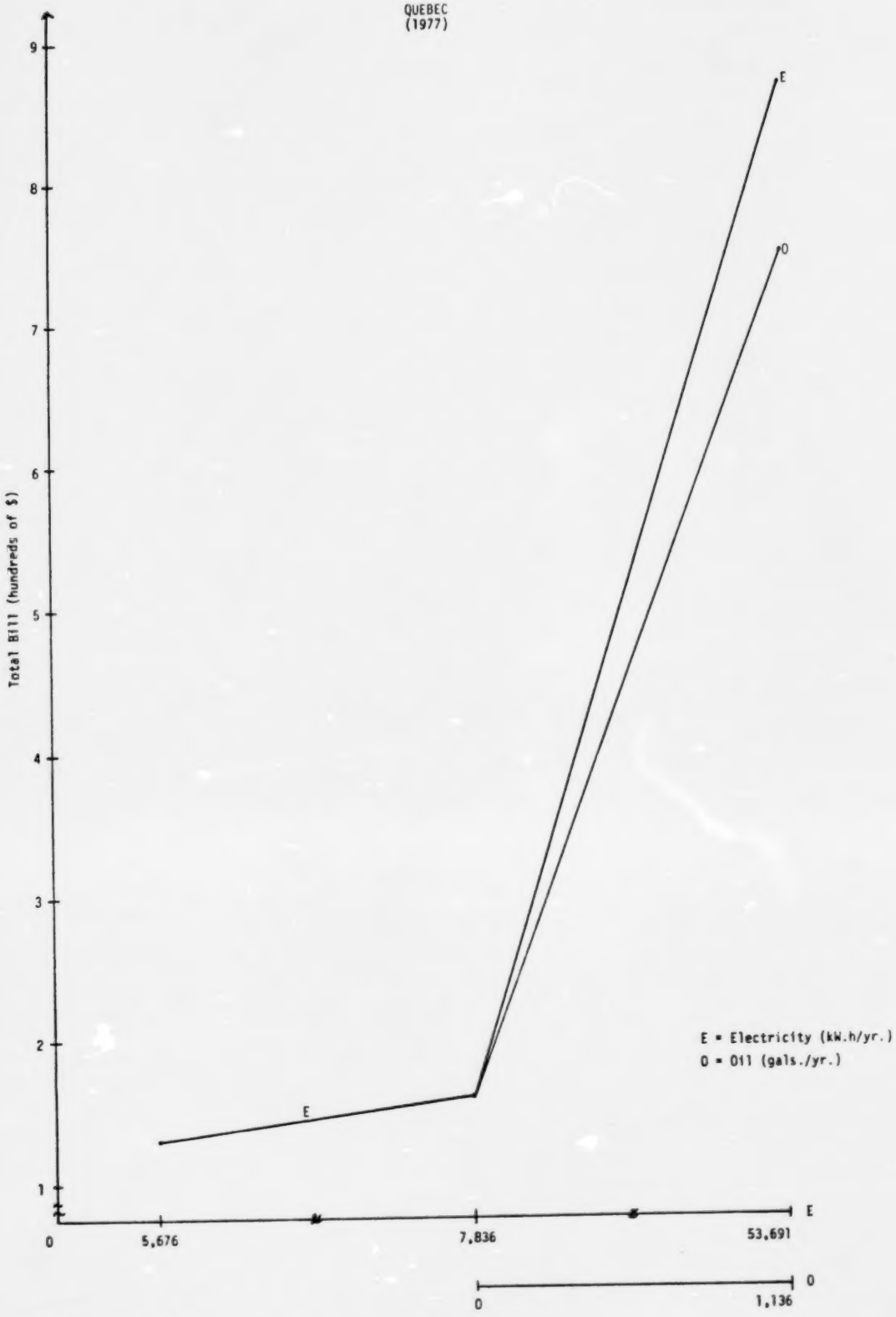
MONTREAL
(1977)*



NOTES: *Gas cost data 1978.
Service charges are included in base electricity usage.

FIGURE 1-K

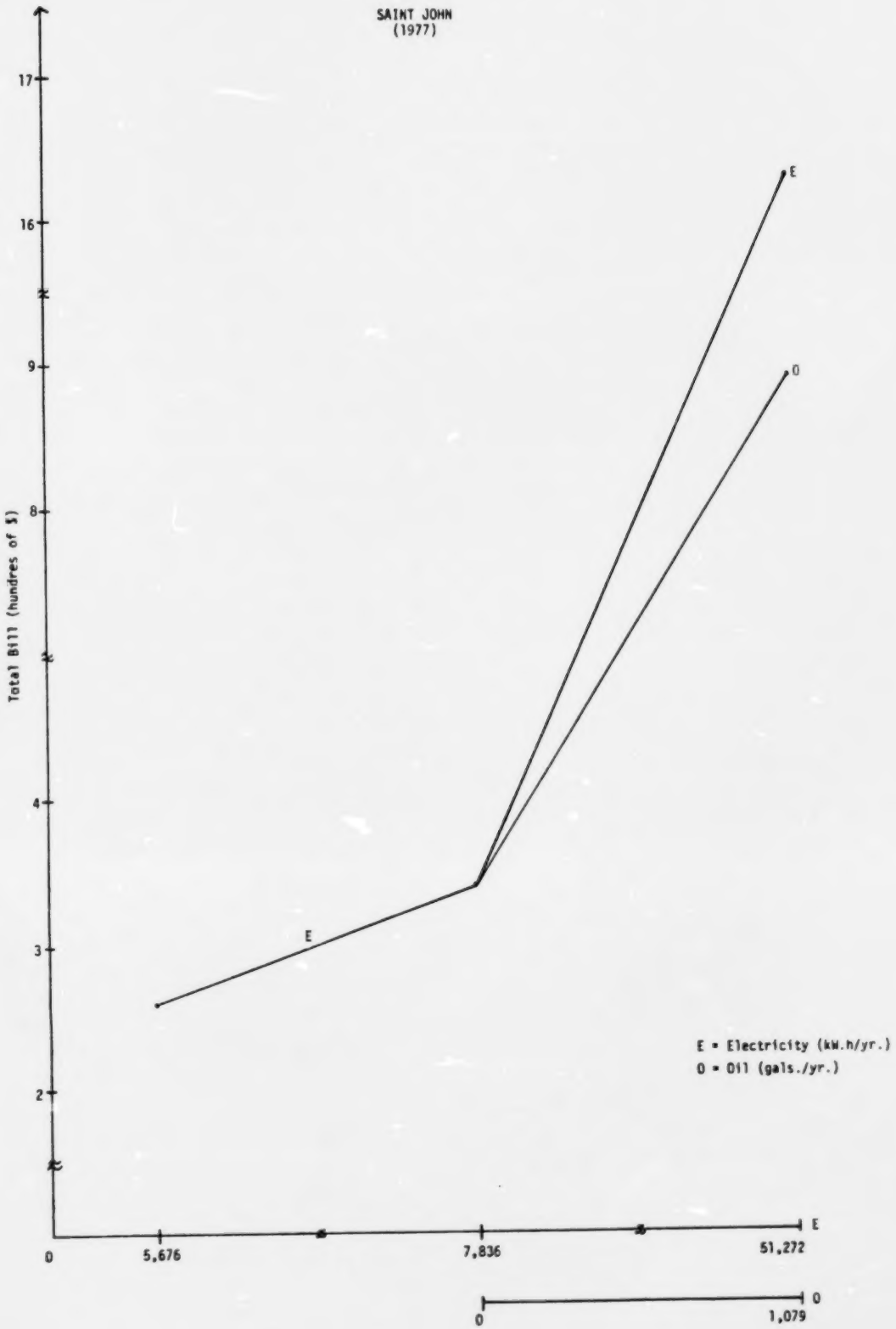
QUEBEC
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 1-L

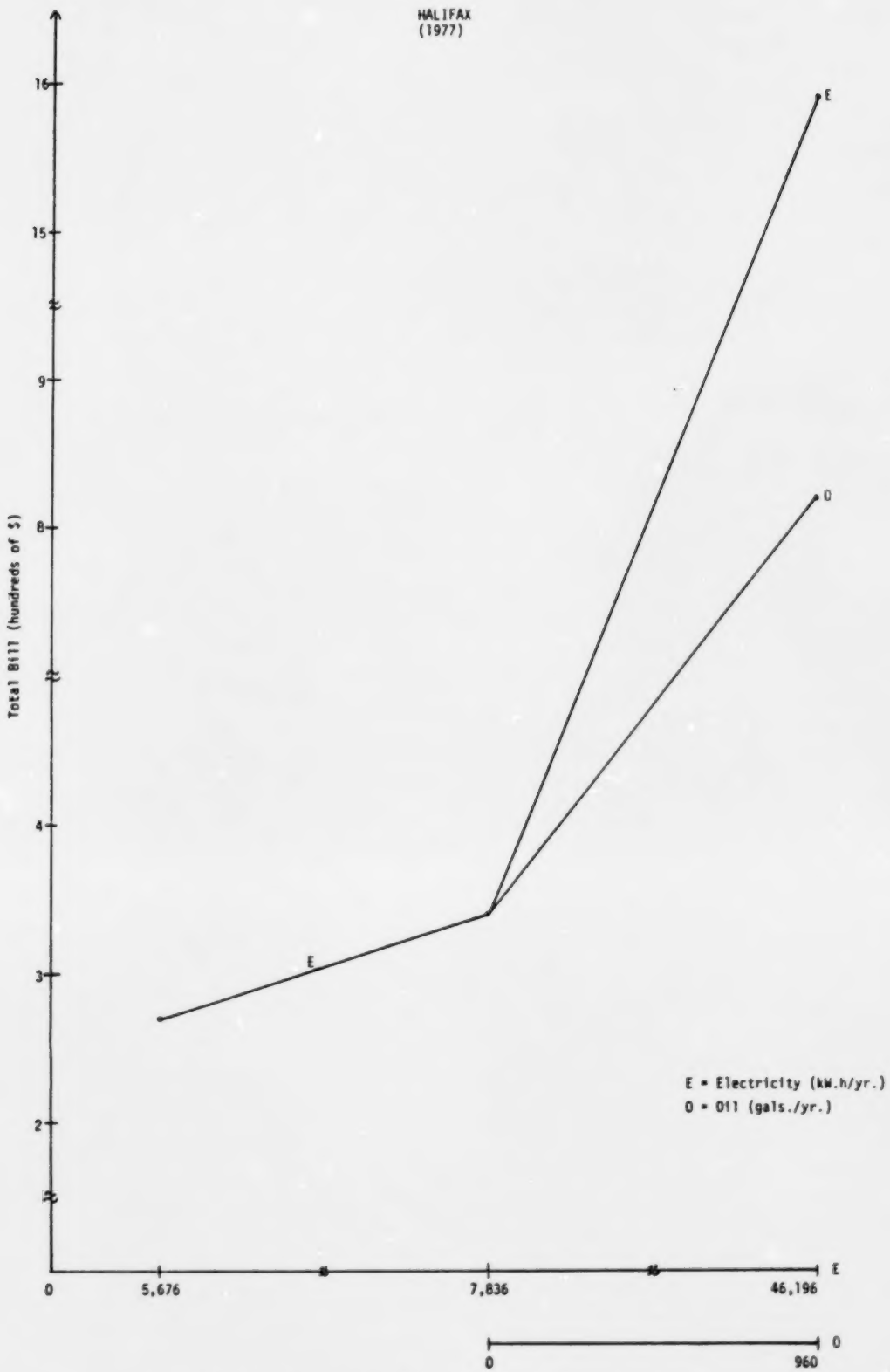
SAINT JOHN
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 1-M

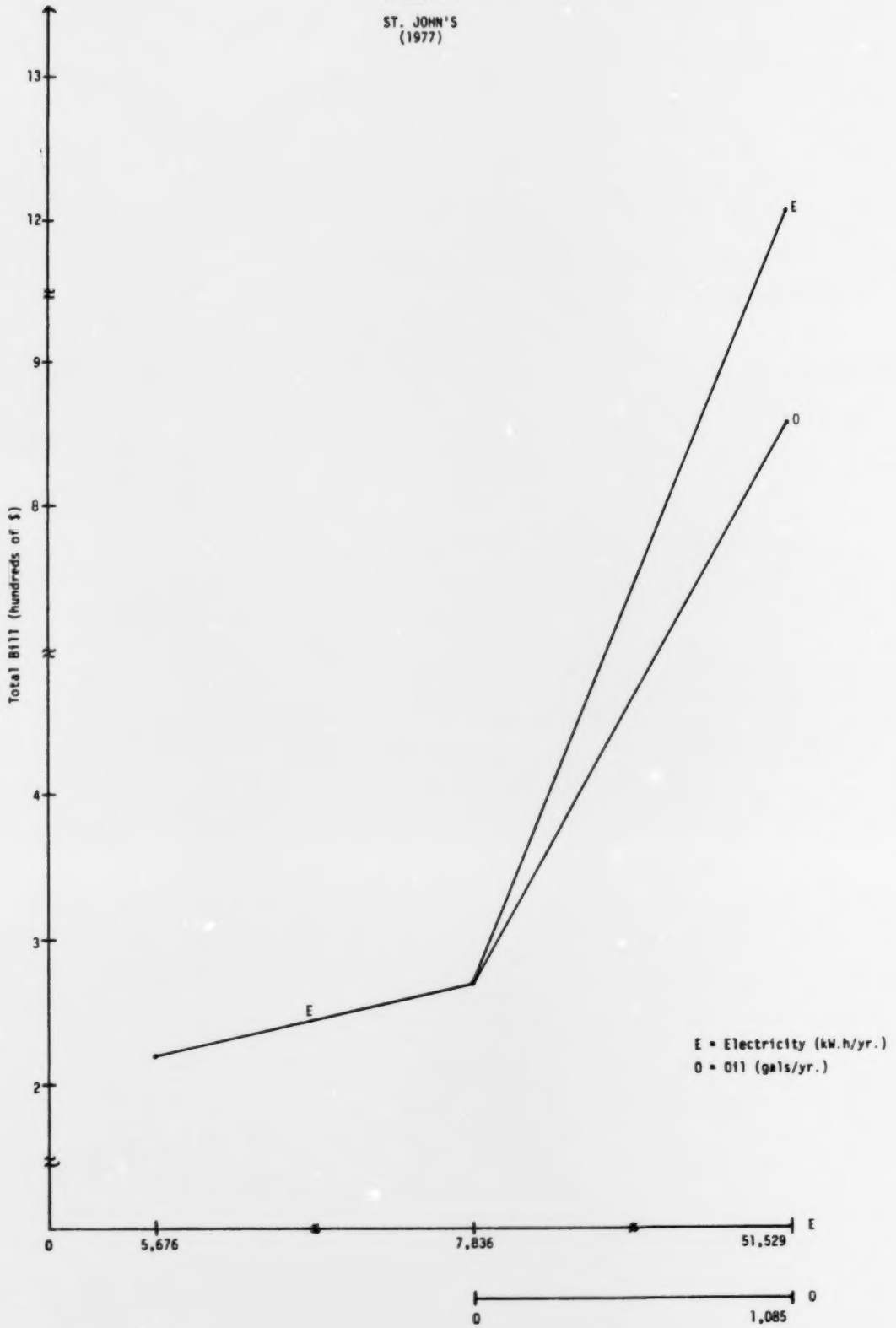
HALIFAX
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 1-N

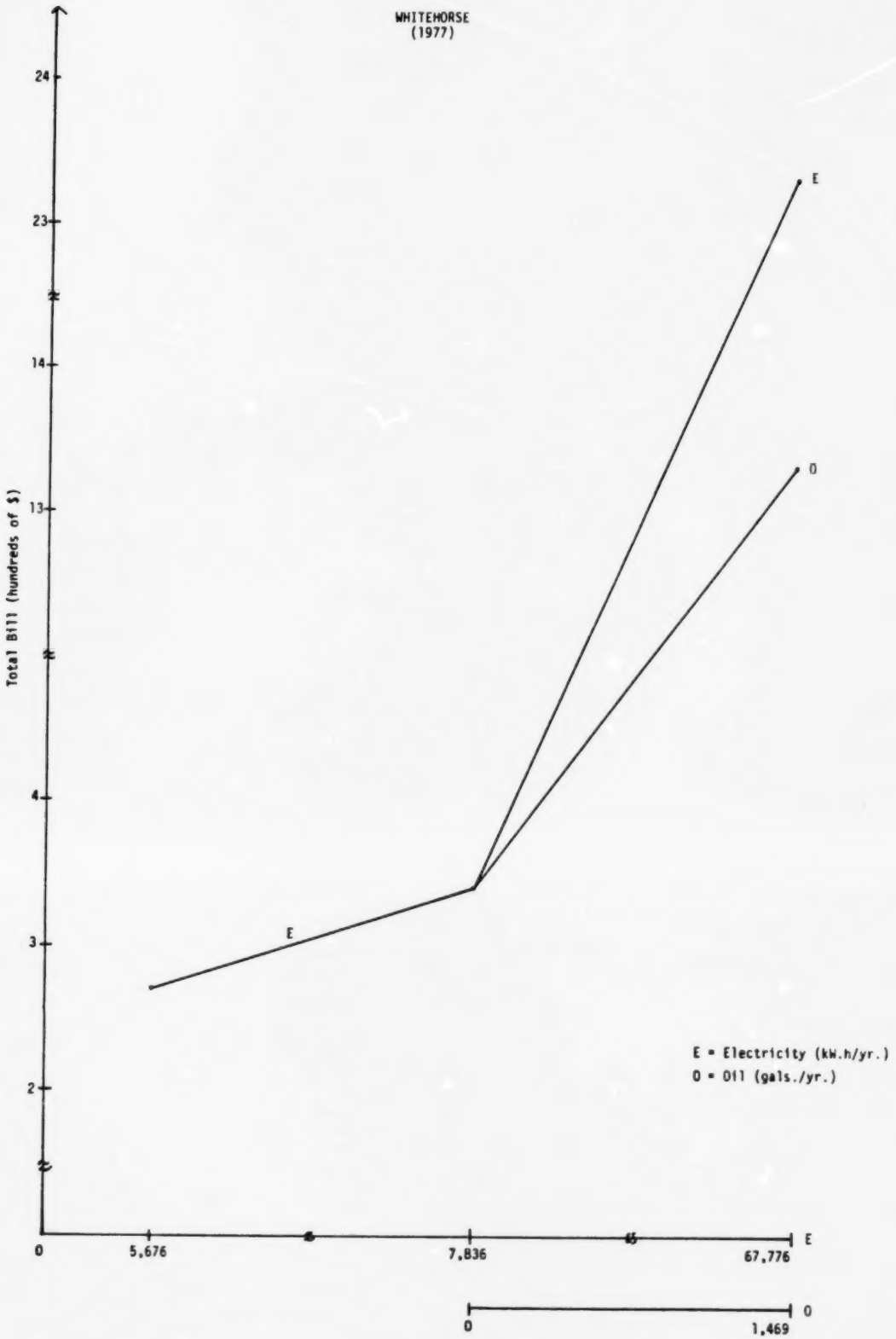
ST. JOHN'S
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 1-0

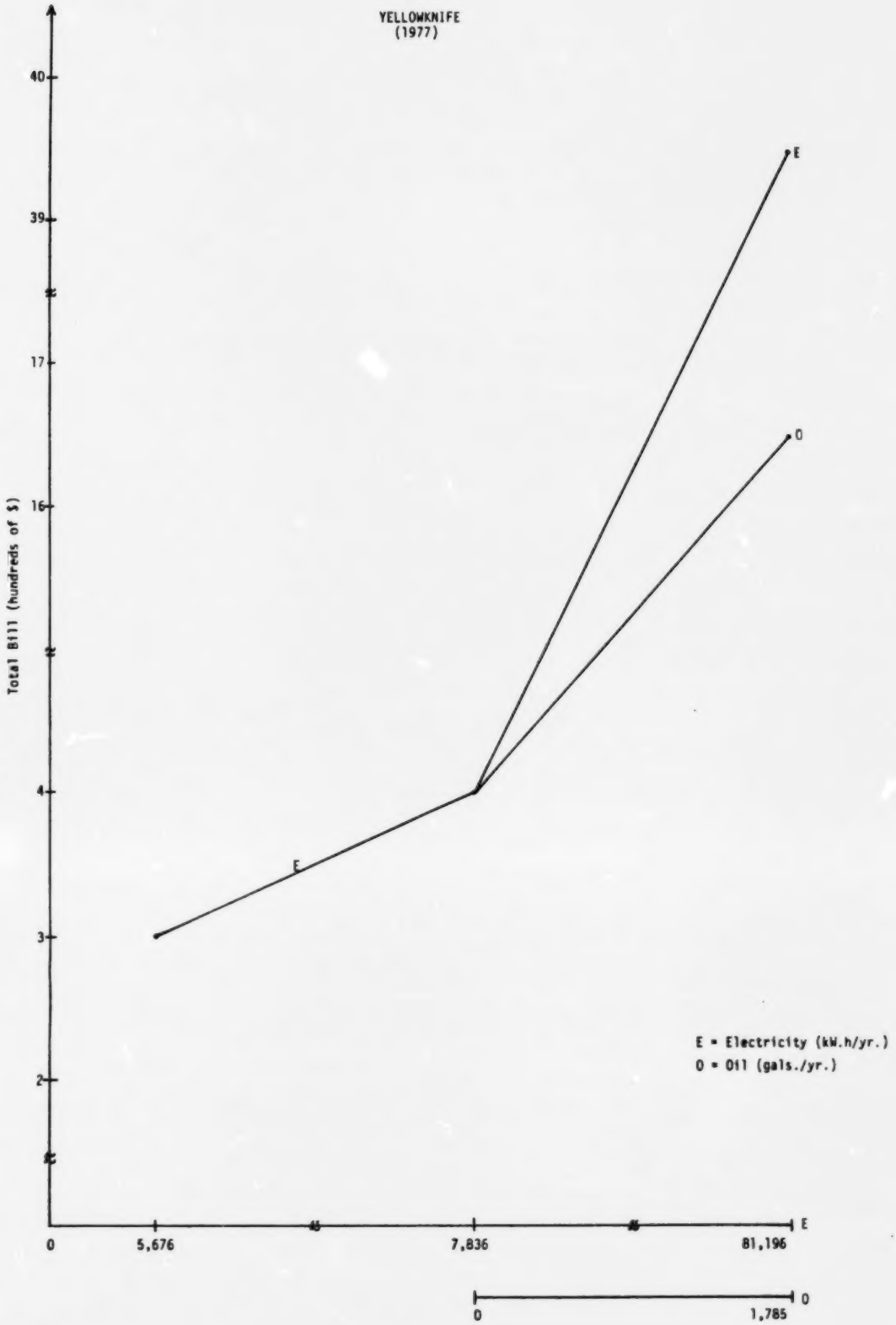
WHITEHORSE
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 1-P

YELLOWKNIFE
(1977)



NOTES: Service charges are included in base electricity usage only.

FIGURE 2-A

CLOTHES DRYERS

(1977)

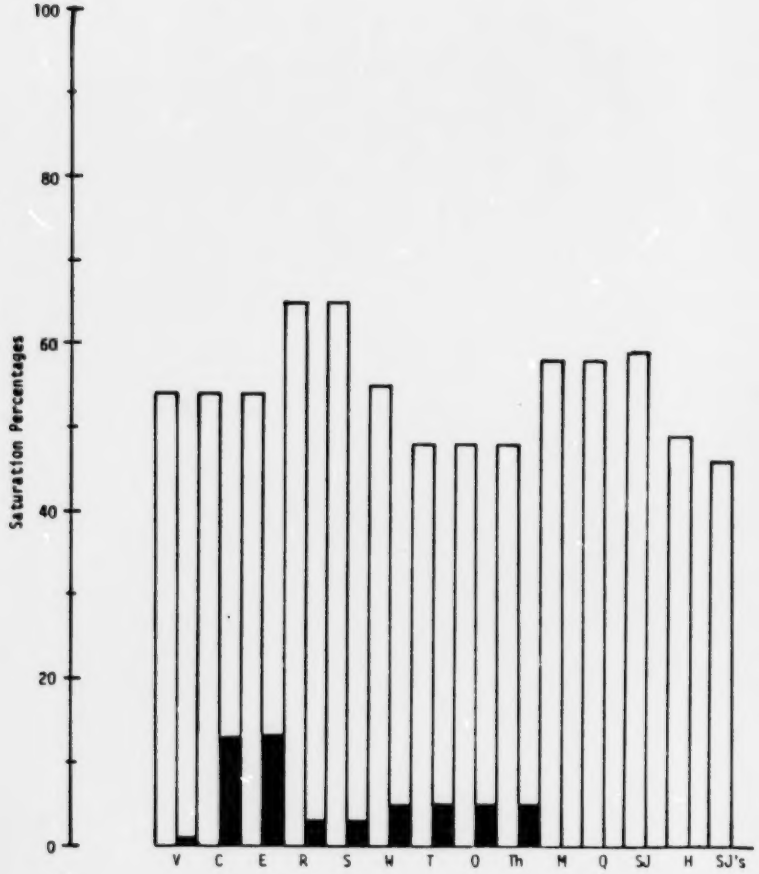
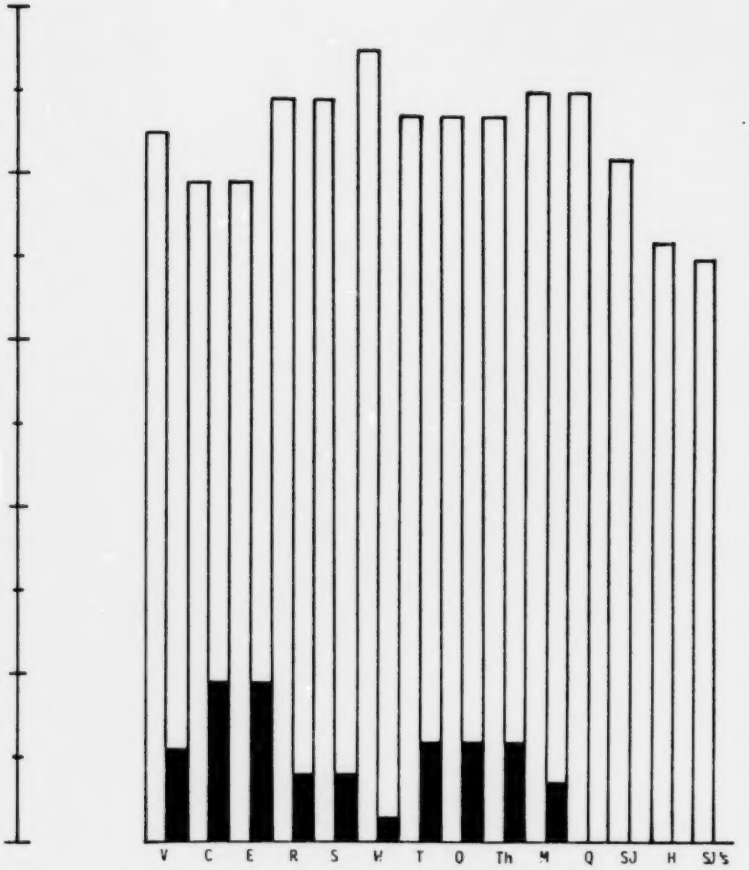


FIGURE 2-B

RANGES

(1977)



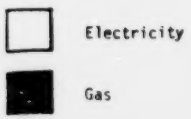


FIGURE 2-C

SPACE HEATING

(1977)

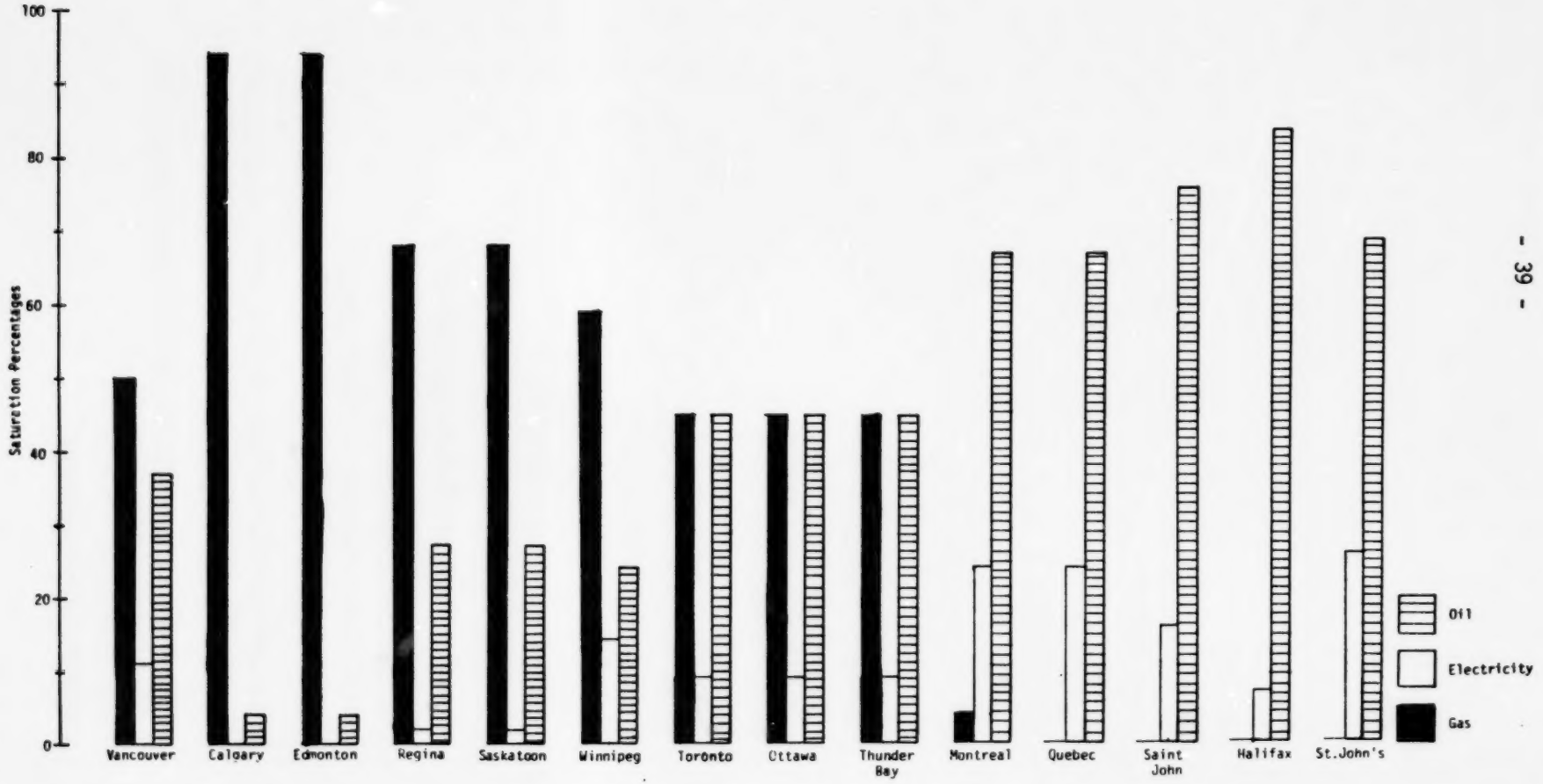
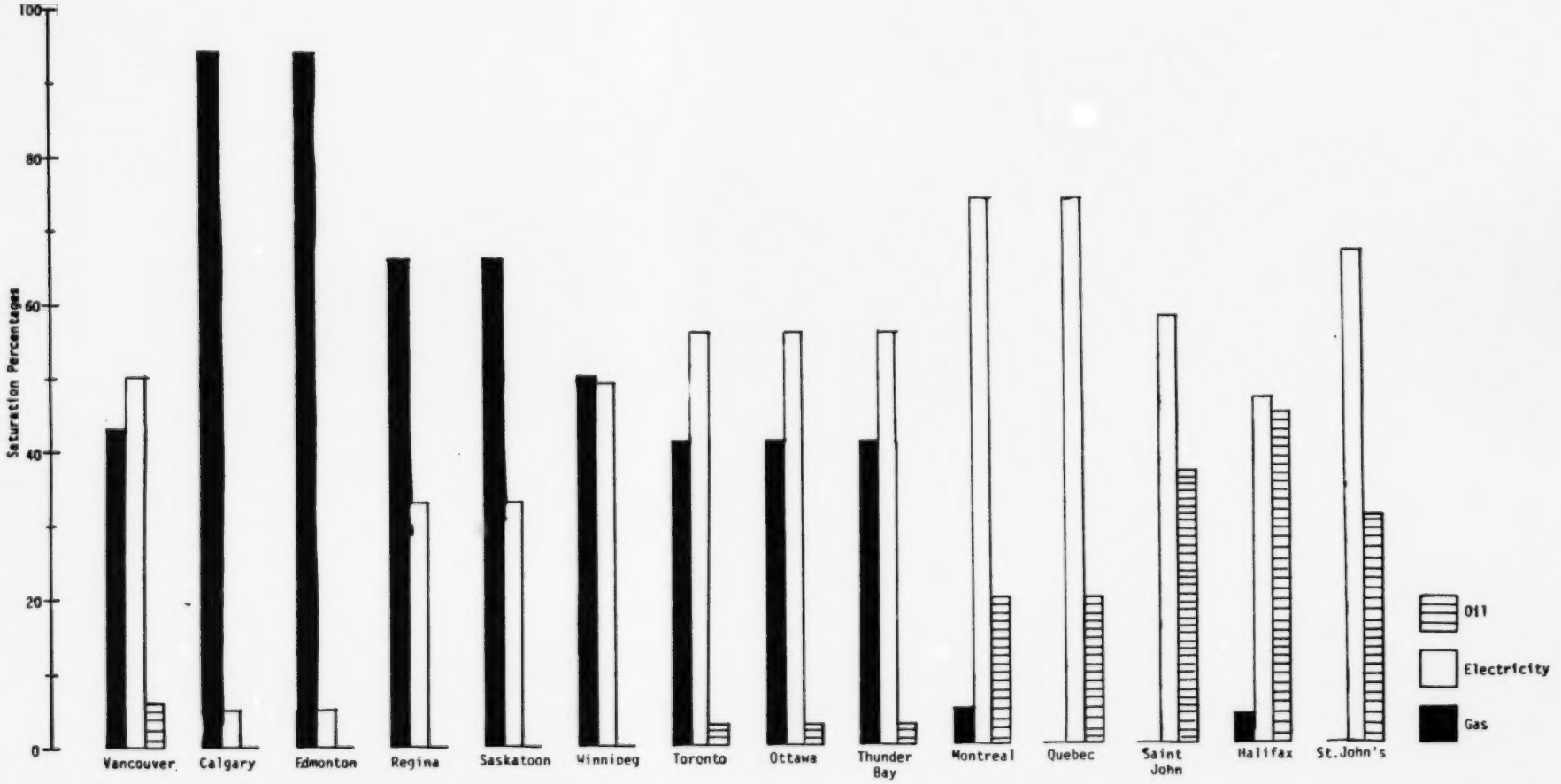


FIGURE 2-D

WATER HEATING

(1977)



original data source from which revisions were made is Statistics Canada.[32] See Appendix A for more details.

Table 11 illustrates the costs associated with least-cost alternatives for each city. The optimal fuel combination is expressed in three parts: a) E (electricity) for basic electricity use, b) E or G (gas) for clothes dryers and ranges, and c) E, G, or O (oil) for space and water heaters. Parts b) and c) will be discussed below.

Vancouver

According to Figure 1-A, the optimal combination of clothes dryers and ranges, and space and water heaters is EO. Figures 2-A and 2-B agree with the clothes dryer and range results. However, discrepancies occur between the space and water heating results and the fuel decision that consumers are actually making. Figure 2-C illustrates gas as being the primary fuel used for space heating, whereas Figure 2-D shows electricity as the predominant fuel used for water heating. Because consumers in Vancouver are not using the least-cost fuel alternative for space and water heating, they are faced with higher home energy costs than actually need be.[33]

Calgary and Edmonton

According to Figures 1-B and C, the optimal combination of clothes dryers and ranges, and space and water heaters is GG. Figures 2-A and B, however, clearly indicate that customers are

TABLE 11

ANNUAL CANADIAN ENERGY COSTS PER HOUSEHOLD
(1977)*

Cities	Optimal Combination of Base Line Usage, Clothes Dryers & Ranges, Space & Water Heaters Respectively**	Costs
Vancouver	EEO	639.96
Calgary	EGG	479.04
Edmonton	EGG	587.88
Regina	EGG	542.64
Saskatoon	EGG	561.60
Winnipeg	EGG	765.96
Toronto	EEO	710.16
Ottawa	EEO	744.84
Thunder Bay	EGG	722.40
Montreal	EEO	671.64
Quebec	EEO	747.96
Saint John	EEO	888.96
Halifax	EEO	821.40
St. John's	EEO	859.20
Whitehorse	EEO	1,333.68
Yellowknife	EEO	1,652.30

NOTES: *1978 for gas rates.

**From graphs.

E = electricity

G = gas

O = oil.

choosing electric clothes dryers and ranges, rather than gas. The additional annual cost associated with this decision is $18.31 for Calgary, and $13.80 for Edmonton. This extra cost is not enough to be an important factor in the customer's decision-making process for selecting alternatives.

Electricity and gas for the operation of clothes dryers and ranges are good substitutes for one another.[34] The main reason why customers choose electricity rather than gas is that electric clothes dryers and ranges are more readily available in retail outlets.

Regina and Saskatoon

According to Figures 1-D and E, the optimal combination of clothes dryers and ranges, and space and water heaters is GG. In spite of this, Saskatchewan households are choosing electric clothes dryers and ranges.[35] The additional annual cost associated with this decision is $16.80 for Regina, and $23.28 for Saskatoon.

Winnipeg

According to Figure 1-F, the optimal combination of clothes dryers and ranges, and space and water heaters is GG. Winnipeg households are actually using electric clothes dryers and ranges.[36] The additional annual cost associated with this decision is negligible.

Toronto and Ottawa

According to Figures 1-G and 1-H, the optimal combination of clothes dryers and ranges, and space and water heaters is EO. Figure 2-C shows that both oil and gas hold equal weights in consumers' fuel decision-making. Figure 2-D shows that consumers are choosing electric water heaters. Results from this study indicate that oil is a cheaper alternative.

Thunder Bay

According to Figure 1-I, the optimal combination of clothes dryers and ranges, and space and water heaters is GG. Figures 2-A and 2-B clearly indicate that electric clothes dryers and ranges are more popular. The additional annual cost between gas or electric clothes dryers and ranges is $6.48, therefore negligible for decision-making purposes. Figure 2-C shows equal saturation percentages for gas and oil space heating. Figure 2-D indicates that consumers are choosing electric water heaters. Results from this study indicate that gas is a cheaper alternative.

Montreal and Quebec

According to Figures 1-J and K, the optimal combination of clothes dryers and ranges, and space and water heaters is EO. Customers are using the least-cost fuel alternative for space heating, however, electric water heating is shown to be preferred over oil. Additional costs to the consumer are associated with

this decision. Gas is not available as a fuel option for Quebec as Trans Canada Pipe Line's transmission line presently terminates just beyond Montreal.

Saint John, Halifax and St. John's

According to Figures 1-L, M, and N, the optimal combination of clothes dryers and ranges, and space and water heaters is EO. Customers are using the least-cost fuel alternative for space heating, however, electric water heating is shown to be preferred over oil. Additional costs to the consumer are associated with this choice.

Whitehorse and Yellowknife

According to Figures 1-O and 1-P, the optimal combination of clothes dryers and ranges, and space and water heating is EO. Saturation percentage figures are not available for comparisons.

Table 12 illustrates the costs associated with three popular fuel alternatives used in households across Canada. The fuel combinations – EE, EG, and EO – are expressed in two parts: a) E (electricity) for clothes dryers and ranges, and b) E, G (gas), or O (oil) for space and water heaters. Base line electricity is assumed.

It should be noted that the above analysis looked only at fuel costs in determining the lowest-cost heating fuel for each city. Other factors, such as equipment capital costs, maintenance costs, installation costs, equipment life, escalation in fuel prices over equipment life, etc., would have to be considered if this topic were to be studied on a larger scale.[37]

TABLE 12

ANNUAL CANADIAN ENERGY COSTS PER HOUSEHOLD
(1977)*

Cities	EE	EG	EO
Vancouver	853.02	718.44	639.96
Calgary	1,220.16	512.09	-
Edmonton	1,214.85	630.12	-
Regina	1,373.46	572.88	847.92
Saskatoon	1,581.34	598.32	876.48
Winnipeg	1,194.49	779.76	818.88
Toronto	1,146.29	902.40	710.16
Ottawa	1,155.23	898.92	744.84
Thunder Bay	1,361.38	748.32	883.68
Montreal	788.75	770.76	671.64
Quebec	874.79	-	747.96
Saint John	1,627.56	-	888.96
Halifax	1,591.68	-	821.40
St. John's	1,207.24	-	859.20
Whitehorse	2,330.69	-	1,333.68
Yellowknife	3,953.48	-	1,652.30

NOTES: *1978 for gas rates.

E = electricity

G = gas

O = oil.

SUMMARY AND CONCLUSIONS

A. Base line electricity usage: Electricity is the only possible energy source.

B. Clothes dryers and ranges: Two fuel sources are available – electricity and gas. Customers seem to use more electric clothes dryers and ranges, possibly due to the fact that electric appliances are more readily available in retail outlets.

C. Space and water heaters: Three fuel sources are available – electricity, gas, and oil. Electricity is found to be the most expensive of all the heating options across Canada. Gas is most popular in the west – Calgary, Edmonton, Regina, Saskatoon, Winnipeg, and Thunder Bay. Oil is used mostly in Vancouver, and the east and north – Toronto, Ottawa, Montreal, Quebec, Saint John, Halifax, St. John's, Whitehorse, and Yellowknife.

FOOTNOTES

[1]Calculated from Statistics Canada, Catalogue No. 57-207, 1976, pp. 26-27.

[2]Exception: Gas is not available to consumers east of Montreal because, at the present time, Trans Canada Pipe Line's transmission line terminates just beyond Montreal, and no distribution lines run to eastern Quebec and the Atlantic provinces. However, extensions have recently been proposed.

[3]Exceptions: a) Gas is not available to consumers east of Montreal, and b) fuel oil is not considered to be available to Albertan consumers because it is not priced in Alberta. (From Statistics Canada and Shell Marketing.)

[4]Conversation with Central Mortgage and Housing, Calgary, June 2, 1978.

[5]Insulation Standards: Ceiling 28; basement walls 8 (assuming less than 50 percent of the wall is above ground); walls 12. Keeping the Heat In, Energy Mines and Resources Canada, pp. 33-34.

[6]Transportation and outdoor recreation uses of energy were excluded from home energy consumption in these comparisons.

[7]For more information, see Appendix B.

[8]Adapted from "Planning Guide for Residential Electric Heating," Canadian Standards Association Special Publication C273.1-1971, Rexdale, Ontario. December 1971, p. 28.

[9]Conversation with Arpi's Industries Ltd., Calgary, June 14, 1978.

[10]"Residential Heating – the Effective Use of Electricity," sponsored by Electric Utilities as members of the Canadian Electrical Association, 6-76-18M, p.4.

[11]Ibid.

[12]Conversations with Calgary Power, Calgary, June 13 and September 13, 1978.
Author's further comments: Higher values of the experience factor may be caused by a) a large family, b) children in the family, e.g. more opening and closing of doors, c) a colder geographic location, and d) physical site of the home, e.g. A house on a treeless hill will receive no shelter from the wind.
The experience factor thus allows the electric utility to make variations in their cost estimates to allow for these types of factors.

[13]"Planning Guide for Residential Electric Heating," Canadian Standards Association.

[14]Ibid, p.10.

[15]Conversation with Calgary Power, Calgary, June 13, 1978.

[16]Clifford Strock and Richard L. Koral, eds., Handbook of Air Conditioning, Heating and Ventilating, The Industrial Press, New York, 1965, pp. 1-111.

[17]Conversation with Arpi's Industries Ltd, Calgary, June 14, 1978.

[18]Handbook of Air Conditioning, Heating and Ventilating, pp. 1-111.

[19]Ibid.

[20]Ibid, pp. 1-110.

[21]Ibid.

[22]Russell E. Caywood, Electric Utility Rate Economics, McGraw-Hill Book Company, Inc., New York, Toronto, London, 1972, p. 39.

[23]Ibid, p. 26.

[24]Ibid.

[25]Ibid, p. 27.

[26]Graphs may be slightly out due to rounding of figures.

[27]0 cubic feet of gas east of Montreal.

[28]Even though space and water heating are treated jointly as major energy users for graph purposes, it should be noted that each of the three fuel possibilities is not necessarily possible to be utilized by every region in Canada.

[29]Declining block rates for gas have not been illustrated in the graph, but have been accounted for in the calculation of end points. This applies to Toronto, as well as Regina, Saskatoon, Winnipeg, Ottawa, Thunder Bay and Montreal.

[30]The Statistics Canada data used are given by province. I assumed that these data could be applied to every city within that province, when in fact, slight variations may occur.

[31]No data available.

[32]i.e., the Statistics Canada data were used in calculating the saturation percentages by province.

[33]B.C. Hydro uses a figure of $329 (with higher insulation standards) as today's energy cost for a winter heating period, including use of both space and water heaters. Different assumptions are made regarding home specifications such as square footage, insulation standards, fuel efficiencies, and so on. Thus the annual cost figure of $329 should only be used for comparative purposes, and not specifically.
SOURCE: Conversation with B.C. Hydro, September 22, 1978.

[34]Conversation with Calgary Power, September 21, 1978.

[35]For the same reasons as Albertans.

[36]Ibid.

[37]Comments on paper by Mr. Ralph Smith, Saskatchewan Department of Mineral Resources.

APPENDICES

APPENDIX A

SATURATION PERCENTAGES

Saturation percentages[1] were used in this study to describe the characteristics of a hypothetical Canadian home. I made an arbitrary decision to choose 40 percent as the saturation point where any point in the region at or above 40 is acceptable, and any point below 40 is unacceptable. An example to clarify this criterion is:

Type of Dwelling	- Single detached	59
	Single attached	8
	Apartment or flat	33

For "single detached," 59 is greater than 40; therefore, the characteristic is accepted.

Exceptions to the above described criterion exist. They are as follows:

a) Freezers - percentage of households with home freezers is 48, and the percentage of households without is 52. Since the satuation percentage of households <u>with</u> freezers is greater than 40, freezers are acceptable.

b) Televisions - theoretically, one black and white TV should have been included, as well as one color. For simplicity, color

was chosen over black and white due to a higher saturation percentage.

c) Clothes dryers - percentage of households with clothes dryers is 57, and the percentage of households without is 43. Since the saturation percentage of households with clothes dryers is greater than 40, clothes dryers are acceptable.[2]

---

[1]Saturation percentages refer to the total number of households included in the sample which use the particular equipment in question over the total number of households, expressed as a percent.

[2]If a higher percentage figure for acceptance were used (for example, 50 percent), the decision as to whether or not to include certain characteristics, such as freezers, would be influenced. Logically, 40 percent seems to be the most reasonable figure.

TABLE A-1

HYPOTHETICAL CANADIAN HOME DESCRIPTION

Saturation Percentages*
1977

Type of dwelling -	Single detached	59
	Single attached	8
	Apartment or flat	33
Bedrooms per dwelling -	None	2
	One	14
	Two	25
	Three	40
	Four	14
	Five	3
	Six or more	1

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, pp. 14 and 16.

NOTES: Figures may not add to 100 due to rounding.

After the writing of this paper, it was brought to the author's attention that Statistics Canada, Catalogue No. 64-202, may have a number of inaccurate statistics. The reader should keep this in mind, especially when reading Table A-5, as errors in the data would lead to errors in interpretation for analysis.

*The total number of households used in the Statistics Canada data is 7,022 for Canada.

TABLE A-2

GENERAL APPLIANCES
Saturation Percentages*
1977

		Households With	Households Without	Total
Air Conditioners[a]		15	85	100
Automatic Dishwashers		22	78	100
Home Freezers		48	52	100
Portable Humidifiers		20	80	100
Record-Playing Equipment		77	23	100
Refrigerators		99	1	100
TV - All types	one	63	3	100
	two or more	34		
Black & White	one	49	44	100
	two or more	7		
Color	one	63	32	100
	two or more	5		
Vacuum Cleaners		89	11	100
Washing Machines[b]		76	24	100

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, pp. 23, 26-27, 30-32.

NOTES: *The total number of households used in the Statistics Canada data is 7,022 for Canada.

[a]Includes window type and central unit.

[b]Includes automatic as well as other.

TABLE A-3

CLOTHES DRYERS

Saturation Percentages[a]
1977

Province	Households With Electric	Gas	Households Without	Total
Canada	53	4	43	100
Newfoundland	46	*	54	100
Nova Scotia	49	*	49	98
New Brunswick	59	*	40	99
Quebec	58	*	42	100
Ontario	48	5	47	100
Manitoba	55	5	40	100
Saskatchewan	65	3	32	100
Alberta	54	13	32	99
British Columbia	54	1	44	99
Yukon[b]				
Northwest Territories[b]				

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202, Annual, May 1977, p. 23.

Figures may not add to 100 due to rounding, or insufficient data.

[a]The total number of households used in the Statistics Canada data is 7,022 for Canada.

[b]No data.

*Data not published.

TABLE A-4

FUEL FOR COOKING EQUIPMENT

Saturation Percentages**
1977

Province	Households with cooking equipment							Households without cooking equipment	Total
	Oil or other liquid fuel	Piped gas	Bottled gas	Electricity	Coal or coke	Wood	Other		
Canada	2	8	2	86	1	1	0	0	100
Newfoundland	22	*	*	70	*	5	*	*	97
Nova Scotia	13	*	7	72	2	6	*	*	100
New Brunswick	9	*	3	82	*	5	*	*	99
Quebec	1	6	1	90	1	1	*	*	100
Ontario	0	11	1	87	0	*	*	*	99
Manitoba	*	3	*	95	*	*	*	*	98
Saskatchewan	*	7	1	89	*	1	*	*	98
Alberta	*	17	2	79	*	*	*	*	98
British Columbia	2	10	1	85	1	*	*	*	99
YukonΔ									
Northwest TerritoriesΔ									

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, p. 22.

NOTE: Figures may not add to 100 due to rounding or insufficient data.

**The total number of households used in the Statistics Canada data is 7022 for Canada.

*Data not published.

ΔNo data.

TABLE A-5

PRINCIPAL HEATING FUEL FOR SINGLE DWELLINGS ONLY

Saturation Percentages**
1977

Province	Oil or other liquid fuel	Piped gas	Bottled gas	Electricity	Coal or coke	Wood	Other	Total
Canada	45	39	1	12	1	2	*	100
Newfoundland	69	*	*	26	*	5	*	100
Nova Scotia	84	*	*	7	2	6	*	99
New Brunswick	76	*	*	16	*	6	*	98
Quebec	67	4	*	24	*	4	*	99
Ontario	45	44	1	9	*	1	*	100
Manitoba	24	59	*	14	*	*	*	97
Saskatchewan	27	66	2	2	*	*	*	97
Alberta	4	91	3	*	1	*	*	99
British Columbia	37	49	1	11	*	2	*	100
YukonΔ								
Northwest TerritoriesΔ								

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, p.19.

NOTES: Figures may not add to 100 due to rounding or insufficient data.
Statistics Canada, Catalogue No. 64-202 may list some inaccurate statistics. Caution should be used in the interpretation of these data for analysis.

**The total number of single dwelling households used in the Statistics Canada data is 4715 for Canada.

*Data not published.

ΔNo data.

TABLE A-6

FUELS FOR PIPED HOT WATER SUPPLY FOR SINGLE DWELLINGS ONLY

Saturation Percentages**
1977

Province	Oil or other liquid fuel	Piped gas	Bottled gas	Electricity	Coal, coke or wood	Other	Total
Canada	10	36	1	52	1	*	100
Newfoundland	31	*	*	67	*	*	98
Nova Scotia	45	*	4	47	4	*	100
New Brunswick	37	*	*	58	3	*	98
Quebec	20	4	1	74	1	*	100
Ontario	3	40	1	56	0	*	100
Manitoba	*	50	*	49	*	*	99
Saskatchewan	*	64	2	33	*	*	99
Alberta	*	91	3	5	*	*	99
British Columbia	6	42	1	50	1	*	100
YukonΔ							
Northwest TerritoriesΔ							

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, p.21.

NOTE: Figures may not add to 100 due to rounding or insufficient data.

**The total number of single dwelling households used in the Statistics Canada data is 4575 for Canada.

*Data not published.

ΔNo data.

TABLE A-7

PRINCIPAL HEATING EQUIPMENT FOR SINGLE DWELLINGS ONLY

Saturation Percentages**
1977

Province	Steam or hot water furnaces	Hot air furnaces[a]	Heating stoves	Electricity	Cook stoves or ranges	Other	Total
Canada	10	72	6	11	1	0	100
Newfoundland	13	33	14	26	11	*	97
Nova Scotia	25	51	11	7	6	*	100
New Brunswick	21	49	10	16	*	*	96
Quebec	12	54	9	24	1	*	100
Ontario	10	78	4	8	*	*	100
Manitoba	5	75	4	13	*	*	97
Saskatchewan	4	88	6	2	*	*	100
Alberta	3	93	4	*	*	*	100
British Columbia	7	77	5	10	1	*	100
YukonΔ							
Northwest TerritoriesΔ							

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, p. 18.

NOTE: Figures may not add to 100 due to rounding or insufficient data.

**The total number of single dwelling households used in the Statistics Canada data is 4715 for Canada.

[a]Includes forced pulse and other.

*Data not published.

ΔNo data.

TABLE A-8

PRINCIPAL HEATING EQUIPMENT FOR SINGLE DWELLINGS ONLY
BY FUEL, CANADA

Saturation Percentages**
1977

Fuel	Steam or hot water furnaces	Hot air furnaces[a]	Heating stoves	Electricity	Cook stoves or ranges	Other	Total
Total	10	72	6	11	1	0	100
Oil or other liquid fuel	16	75	8	*	1	*	100
Piped gas	6	91	2	*	*	*	99
Bottled gas	*	77	20	*	*	*	97
Electricity	*	4	*	95	*	*	99

SOURCE: Data calculated from Statistics Canada, Catalogue No. 64-202 Annual, May 1977, p. 17.

NOTE: Figures may not add to 100 due to rounding or insufficient data.

**The total number of single dwelling households used in the Statistics Canada data is 4715 for Canada.

[a]Includes forced pulse and other.

*Data not published.

APPENDIX B

ELECTRICITY CONSUMPTION IN THE HOME

It is arbitrarily assumed that home lighting electricity consumption will be in the form of incandescent lighting.

TABLE B-1

DETERMINATION OF HOME LIGHTING ELECTRICITY CONSUMPTION
(kilowatt-hours)

Number of Rooms and Lamps	Number of Lamps	kW.h Use* (per mo.)	Total kW.h Use (per mo.)
Living room with tri-light table lamps	2	8	16
Dining room with 5-lamp chandelier	1	9	9
Bathroom with single lamp ceiling fixture	1	2	2
3 Bedrooms each with 3-lamp ceiling fixture	3	3	9
Kitchen with 3-lamp ceiling fixture	2	3	6
Entrance with single lamp ceiling fixture	1	2	2
Back porch with single lamp ceiling fixture	1	2	2
Front porch with single lamp ceiling fixture	1	2	2

Monthly total = 48
Annual total = 576

*"How you use the electricity you use," Ontario Hydro 984-0343:1. A Conserve Energy Publication.

TABLE B-2

MISCELLANEOUS ELECTRICITY CONSUMPTION

The following electric applicances use 2 KW.h or less per month, and are classified as miscellaneous:

Blender	Knife
Can opener	Mixer
Clock	Power saw
Drill	Radio
Floor polisher	Rotisserie
Food waste disposer	Sewing machine
Heating pad	Shaver
Heat lamp	Sun lamp
Hedge trimmer	Toothbrush
Kitchen fan	Waffle iron

SOURCES: "How you use the electricity you use," Ontario Hydro. 984-0343:1 A Conserve Energy Publication.

"Your meter is running. A guide to managing your kilowatts," Calgary Power.

Miscellaneous also includes electricity users such as blankets, coffee makers, deep fat fryers, frying pans, hair dryers, hot plates, irons, kettles and toasters.

APPENDIX C

CLIMATIC DATA

TABLE C-1

DEGREE-DAYS BELOW 18°C, 1977
(Normalized)

Cities	January	February	March	April	May	June	July	August	September	October	November	December	Total
Vancouver	484	383	377	272	174	85	35	40	114	245	358	440	3,007
Calgary	899	719	691	439	269	150	65	97	221	383	619	793	5,345
Edmonton	1,016	806	727	421	222	109	47	82	215	388	666	890	5,589
Regina	1,094	914	817	441	234	97	29	46	198	394	697	959	5,920
Saskatoon	1,139	936	829	445	233	97	30	54	204	402	714	994	6,077
Winnipeg	1,126	953	810	441	236	76	21	38	175	356	674	983	5,889
Toronto	755	671	587	348	187	48	10	19	98	254	438	667	4,082
Ottawa	899	778	654	371	181	44	10	28	123	290	499	796	4,673
Thunder Bay	1,017	877	749	469	301	131	47	71	204	371	616	893	5,746
Montreal	765	757	636	369	168	38	7	20	106	269	471	765	4,371
Quebec City	919	810	692	441	232	76	22	45	155	332	533	823	5,080
Saint John	790	721	640	447	286	135	49	62	162	313	464	702	4,771
Halifax	676	628	582	419	278	133	37	30	105	251	391	593	4,123
St. John's	674	629	634	507	387	229	98	91	184	337	435	599	4,804
Whitehorse	1,143	881	798	543	338	171	125	176	307	537	812	1,048	6,879
Yellowknife	1,445	1,235	1,138	777	435	178	76	126	333	596	967	1,287	8,593

SOURCE: Data normalized from Heating Degree-Day Summary, Fisheries and Environment Canada. Atmospheric Environment.

"Departure from Normal" is based on a thirty year average from 1941-1970. (Conversation with Government of Canada's Environment Canada, Atmospheric Environment Service, Weather-Climatology office, July 31, 1978.)

TABLE C-2

CONVERSION OF DEGREE-DAYS FROM CELSIUS TO FAHRENHEIT
1977 Normalized Data

Cities	Degree-Days Celsius	Degree-Days Fahrenheit[a]
Vancouver	3,007	5,431
Calgary	5,345	9,639
Edmonton	5,589	10,078
Regina	5,920	10,674
Saskatoon	6,077	10,957
Winnipeg	5,889	10,618
Toronto	4,082	7,366
Ottawa	4,673	8,429
Thunder Bay	5,746	10,361
Montreal	4,371	7,886
Quebec City	5,080	9,162
Saint John	4,771	8,606
Halifax	4,123	7,439
St. John's	4,804	8,665
Whitehorse	6,879	12,400
Yellowknife	8,593	15,485

SOURCE: Donald W. Boyd, "Converting Heating Degree-Days from below 65°F to Below 18°C," National Research Council of Canada, No. 98, Ottawa, August 1975.

[a]Calculated from $A = 9(B + Nz)/5$
A = the F degree-days below 65°F.
B = the C degree-days below 18°C.
Nz, in C degree-days, is 10 for 208 and up C degree-days.

TABLE C-3

MINIMUM MONTHLY AVERAGE TEMPERATURES
Celsius

Cities	January	February	November	December
Vancouver	-4.7	-3.0	-6.3	-6.4
Calgary	-30.1	-18.4	-22.6	-34.2
Edmonton	-37.2	-22.9	-26.0	-39.2
Regina	-36.9	-24.7	-27.6	-37.5
Saskatoon	-37.5	-24.1	-28.3	-38.0
Winnipeg	-36.9	-32.4	-26.0	-33.8
Toronto	-29.8	-23.9	-10.6	-30.0
Ottawa	-30.0	-24.6	-13.6	-26.7
Thunder Bay	-34.6	-29.0	-25.0	-33.9
Montreal	-28.8	-23.6	-12.8	-26.6
Quebec City	-30.4	-24.7	-16.7	-29.5
Saint John	-30.2	-21.5	-11.1	-23.2
Halifax	-21.6	-17.7	-6.8	-25.2
St. John's	-15.5	-18.0	-4.9	-13.9
Whitehorse	-34.5	-27.2	-26.1	-46.2
Yellowknife	-42.4	-36.1	-31.0	-44.4

SOURCE: Canadian Weather Review, Fisheries and Environment Canada. Atmospheric Environment, 1975 - Vol. 13, No. 12; 1976 - Vol. 14, Nos. 1, 2, 11; 1977 - Vol. 15, Nos. 1, 2, 11, 12.

TABLE C-4

CONVERSION OF LOWEST MINIMUM MONTHLY AVERAGE TEMPERATURES FROM CELSIUS TO FAHRENHEIT

Cities	Degrees Celsius	Degrees Fahrenheit
Vancouver	-6	21
Calgary	-34	-29
Edmonton	-39	-38
Regina	-38	-36
Saskatoon	-38	-36
Winnipeg	-37	-35
Toronto	-30	-22
Ottawa	-30	-22
Thunder Bay	-35	-31
Montreal	-29	-20
Quebec City	-30	-22
Saint John	-30	-22
Halifax	-25	-13
St. John's	-18	0
Whitehorse	-46	-51
Yellowknife	-44	-47

To convert ^{o}C to ^{o}F, multiply the centigrade degree number by 9/5 and add 32. From V.L. Parsegian, A.S. Meltzer, A.S. Luchins, and K.S. Kinerson, Introduction to Natural Science, Academic Press Inc., New York, 1968, p. 313.

APPENDIX D

HEATING UNIT EFFICIENCY

Heating unit efficiency expresses "the heat delivered by a furnace or boiler as a percentage of the heat provided in the fuel and which is the efficiency normally used in describing the performance of a unit under rated, or stated, load conditions."[a] Using this definition, it will be assumed that

1) electricity is 100 percent efficient,[b]
2) gas is 80 percent efficient,[c] and
3) oil is 80 percent efficient.[d]

It should be noted that considerable controversy exists over efficiency percentage figures for oil and gas. Certain factors, such as whether or not the furnace is combusting, greatly influence the actual efficiency level at any given time.

[a] ASHRAE Handbook and Product Directory 1973 Systems, published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York.

[b] Conversation with Calgary Power, June 13, 1978.

[c] Conversation with Canadian Western Natural Gas, June 13, 1978.

[d] Conversation with Shell Oil, July 19, 1978.

APPENDIX E

RATES

TABLE E-1

RESIDENTIAL ELECTRICITY RATES
(1977)

Cities	Utility	Service Charge (per mo.)	Energy Charge (per mo.)
Vancouver	B.C. Hydro	* $3.00/period Δ*$6.14/period	*First 550 kW.h/period @ 4.6¢/kW.h All additional kW.h/period @ 2.0¢/kW.h
Calgary	City of Calgary	Δ $2.70	$2.70/service (no kW.h) Plus all kW.h @ 2.13¢/kW.h
Edmonton	Edmonton Power	$2.75 Δ Service charge + energy charge	2.05¢/kW.h
Regina	Saskatchewan Power Corporation	Δ $1.80	First 20 kW.h @ $1.80 Next 100 kW.h @ 3.8¢/kW.h Next 200 kW.h @ 2.7¢/kW.h All additional kW.h @ 2.2¢/kW.h
Saskatoon	City of Saskatoon	Δ $1.50	First 50 kW.h @ 7.8¢/kW.h Next 200 kW.h @ 3.0¢/kW.h All over 250 kW.h @ 2.5¢/kW.h
Winnipeg	Winnipeg Hydro	$2.30 Δ Service charge	First 200 kW.h used @ 3.0¢/kW.h All additional kW.h @ 1.9¢/kW.h Water Heater Service: see attached.
Toronto	Toronto Hydro-Electric System	Δ $4.20	First 50 kW.h @ 6.7¢/kW.h Next 200 kW.h @ 3.21¢/kW.h All additional kW.h @ 2.4¢/kW.h Water Heater Service: see attached.
Ottawa	Ottawa Hydro-Electric Commission	Δ $4.00	First 50 kW.h @ 4.8¢/kW.h Next 200 kW.h @ 2.4¢/kW.h All additional kW.h @ 2.25¢/kW.h
Thunder Bay	Thunder Bay Hydro-Electric Commission	Δ $3.50	First 50 kW.h @ 7.3¢/kW.h Next 200 kW.h @ 3.65¢/kW.h All additional kW.h @ 2.2¢/kW.h
Montreal	Hydro-Quebec	**$1.00 Δ $2.00	First 100 kW.h @ 3.8¢/kW.h Next 200 kW.h @ 1.7¢/kW.h All additional kW.h @ 1.55¢/kW.h
Quebec City	Hydro-Quebec	as above	as above
Saint JohnΔΔ	Power Commission of the City of Saint John	$3.00 Δ $3.00	First 700 kW.h @ 3.89¢/kW.h All additional kW.h @ 2.95¢/kW.h Water Heater Service: 40 gals. - $1.60 60 gals. - $2.25
Halifax	Nova Scotia Power Corporation	$3.95 Δ $3.95	First 200 kW.h @ 4.40¢/kW.h Next 500 kW.h @ 3.50¢/kW.h All additional kW.h @ 3.25¢/kW.h
St. John's	Newfoundland Light & Power Co. Limited	Δ $4.25	First 15 kW.h @ $4.25 Next 300 kW.h @ 3.6¢/kW.h All additional kW.h @ 2.15¢/kW.h
WhitehorseΔΔ	Yukon Electrical Company	Δ $2.75	First 40 kW.h @ 7.43¢/kW.h Next 160 kW.h @ 5.71¢/kW.h Next 100 kW.h @ 4.56¢/kW.h All over 300 kW.h @ 3.32¢/kW.h
YellowknifeΔΔ	Plains Western Natural Gas	Δ $5.55	First 75 kW.h @ 7.47¢/kW.h All additional kW.h @ 4.84¢/kW.h

SOURCE: Table data taken from CEA Rate Book, Eastern and Western Canada. Exceptions: 1) Saint John, data taken from the rates effective April 1, 1978, for the Power Commission of the City of Saint John; 2) Whitehorse, data taken from the rates effective May 1, 1978, for Yukon Electrical Company; 3) Yellowknife, conversation with Plains Western Natural Gas, June 1, 1978.

* for a period of 2 mos.
** fixed charge
Δ minimum monthly bill
ΔΔ 1977 data unavailable; 1978 data used.

TABLE E-2

RESIDENTIAL GAS RATES
(1978)

Cities	Utility	Service Charge (per mo.)	Energy Charge (per mo.)
Vancouver	B.C. Hydro & Power Authority	* $8.00/period Δ*$8.00/period	*All therms/period @ .20¢/therm
Calgary	Canadian Western Natural Gas Company Limited	**$4.00	Fixed charge $4.00 Plus commodity charge/mcf .470 Plus additional charges from Rider "C" .543 Plus municipal taxation % on Rider "A" or "B" 11.11% Minus provincial discount 4.00%
Edmonton	Northwestern Utilities Limited	**$4.20	Fixed charge $4.20 Plus commodity charge/therm 4.55¢ Plus municipal taxation % on Rider "A" 11.11% Plus additional charges from Rider A-2 6.67¢/therm Plus additional charges from Riders 4.00¢/therm
Regina	Saskatchewan Power Corporation	Δ$5.00	First 3 mcf @ $2.56 Next 3 mcf @ $1.83/mcf Next 144 mcf @ $1.44/mcf All additional mcf @ $1.43/mcf (assuming normal Btu gas)[a]
Saskatoon	Saskatchewan Power Corporation	as above	as above
Winnipeg	Greater Winnipeg Gas Company	Δ for connected loads of: less than 300 cu.ft./hr. $1.25[b] between 300 and 1,000 cu.ft./hr. $5.00 between 1,000 and 5,000 cu.ft./hr. $25.00 over 5,000 cu.ft./hr. $100.00	First 0.2 mcf @ $1.25 Next 1.3 mcf @ $2.807/mcf Next 198.5 mcf @ $2.272/mcf All additional mcf @ $2.128/mcf
Toronto	The Consumers' Gas Company	Δ $2.55	First 4 ccf @ $2.55 Next 6 ccf @ 33.99¢/ccf Next 20 ccf @ 31.41¢/ccf All additional ccf @ 28.81¢/ccf Water Heater Service: In the block of 11 ccf to 30 ccf 28.81¢/ccf
Ottawa	The Consumers' Gas Company	as above	as above
Thunder Bay	Northern and Central Gas Corporation Ltd.	Δ $4.50	First 1 mcf @ $4.50/mcf Next 1 mcf @ $2.30/mcf Next 2 mcf @ $2.10/mcf Next 4 mcf @ $2.00/mcf Next 12 mcf @ $1.90/mcf All additional mcf @ $1.80/mcf
Montreal	Gaz Metropolitain, Inc.	Δ $2.05	First 1 ccf @ $2.05 Next 29 ccf @ .34¢/ccf Next 70 ccf @ .24¢/ccf All additional ccf @ .23¢/ccf
Quebec	-	-	-
Saint John	-	-	-
Halifax	-	-	-
St. John's	-	-	-
Yellowknife[c]	-	-	-
Whitehorse	-	-	-

SOURCE: Table data taken from Canadian Gas Association, Canadian Gas Rates, Don Mills, Ontario, 1978. Exception: 1) Whitehorse, letter from Canadian Propane Gas & Oil Ltd., June 15, 1978.

* for a period of 2 mos. Δ minimum monthly bill
** fixed charge

[a] Normal Btu gas contains approximately 1,000 Btus per cubic foot.
[b] Capacity of residential furnace is about 1,500 cu.ft. per day. From conversation with Martin Johnson of Martin Johnson & Associates, July 26, 1978.
[c] Propane 58.75¢/gal. From conversation with Canadian Propane Gas & Oil Ltd., July 24, 1978.

TABLE E-3

RESIDENTIAL OIL RATES
(1977)

Cities	January	February	March	April	May	June	July	August	September	October	November	December	Monthly Average
Vancouver	.473	.473	.497	.497	.497	.498	.498	.498	.530	.530	.530	.532	.504
Calgary	*	*	*	*	*	*	*	*	*	*	*	*	*
Edmonton	*	*	*	*	*	*	*	*	*	*	*	*	*
Regina	.454	.454	.478	.478	.478	.481	.481	.481	.513	.513	.513	.512	.486
Saskatoon	.450	.450	.473	.473	.473	.476	.476	.476	.508	.508	.508	.508	.482
Winnipeg	.444	.444	.470	.470	.470	.474	.474	.474	.507	.507	.507	.506	.479
Toronto	.466	.466	.495	.495	.495	.494	.494	.494	.528	.528	.528	.528	.501
Ottawa	.484	.484	.511	.511	.511	.510	.510	.510	.546	.546	.546	.544	.518
Thunder Bay	.480	.480	.505	.505	.505	.506	.506	.506	.541	.541	.541	.540	.513
Montreal	.473	.473	.498	.498	.498	.498	.498	.498	.532	.532	.532	.524	.505
Quebec	.480	.480	.510	.510	.510	.510	.510	.510	.542	.542	.542	.526	.514
Saint John	.474	.474	.500	.500	.500	.502	.502	.502	.534	.534	.534	.534	.508
Halifax	.461	.461	.484	.484	.484	.496	.496	.496	.528	.528	.528	.532	.498
St. John's	.512	.512	.539	.539	.539	.539	.539	.539	.571	.571	.571	.572	.545
Yellowknife[a]	.676	.676	.676	.676	.676	.676	.676	.676	.676	.676	.676	.676	.676
Whitehorse[b]	.700	.700	.700	.700	.700	.700	.700	.700	.700	.700	.700	.700	.700

SOURCE: Statistics Canada, (Average fuel oil prices), Correspondence dated April 3, 1978.

* Fuel oil is not priced in Alberta. (From CERI correspondence with Statistics Canada, April 3, 1978, and conversation with Shell Canada Limited Marketing Office, May 29, 1978.)

[a] 67.6¢/gallon is in tank truck, i.e., bulk delivery of 1,500 gallons and upwards. If delivery is in barrels, i.e., 45 gallon drums, an additional 31¢/gallon is charged. (From conversation with Imperial Oil Limited, June 5, 1978.)

[b] Conversation with Imperial Oil Limited, June 5, 1978.